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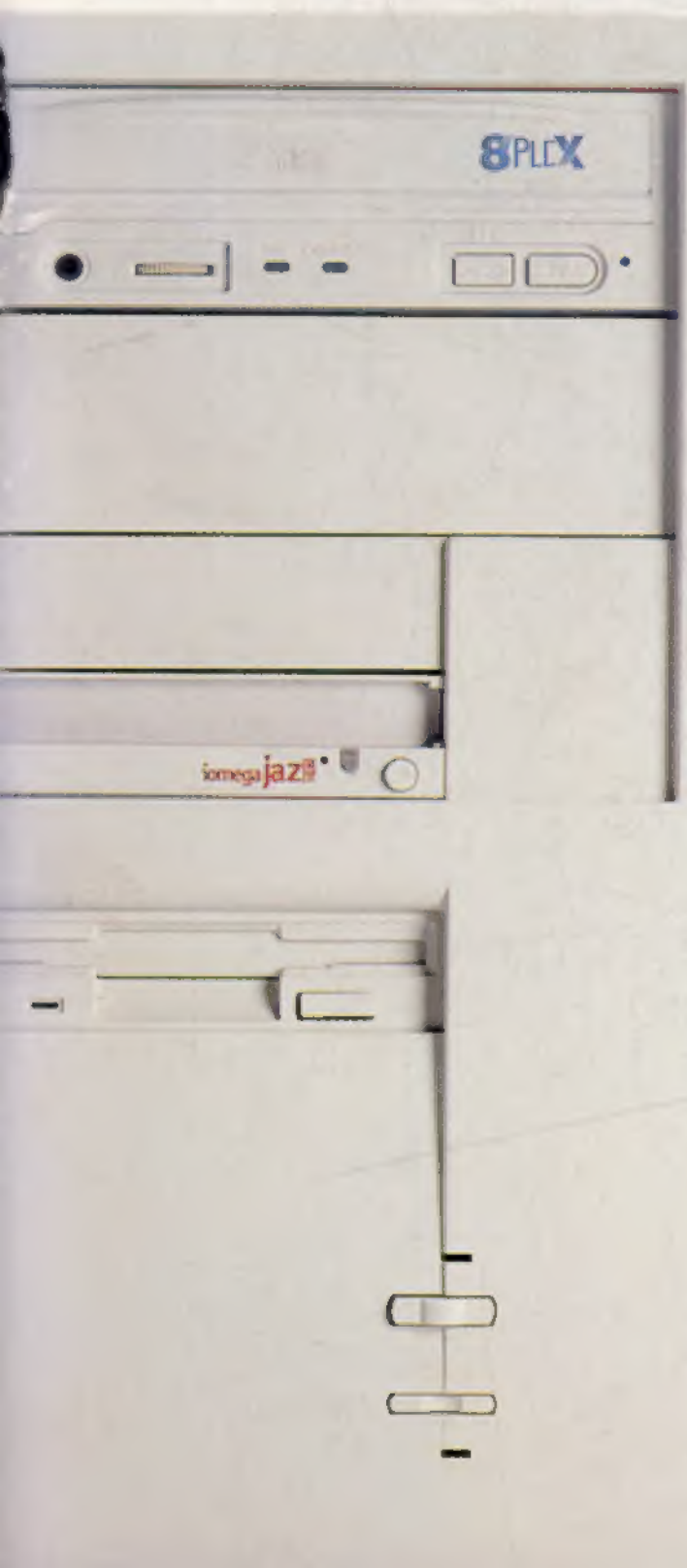
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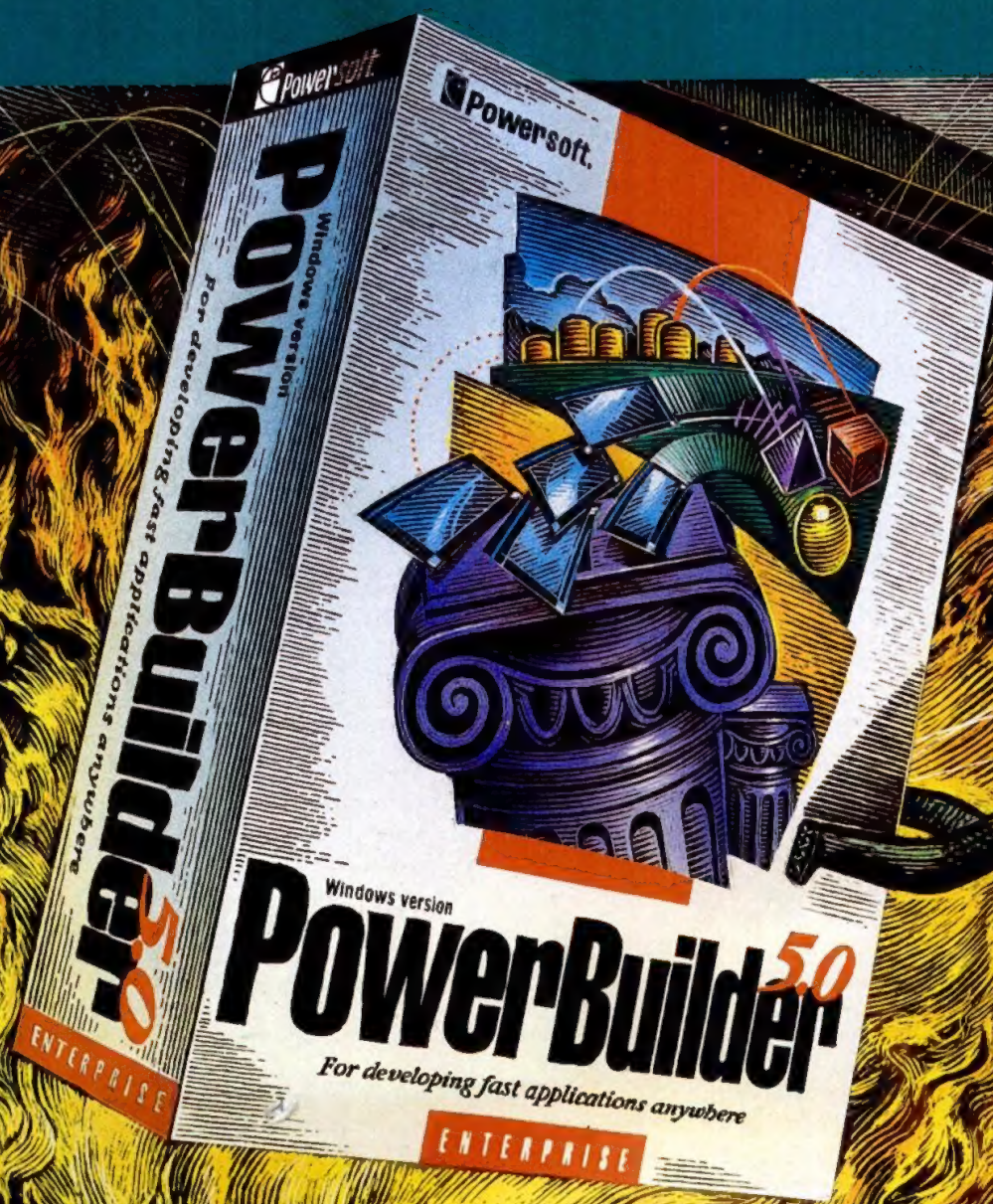
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Even veteran members of our PC Labs staff take a deep breath when we ramp up for our semiannual roundup of desktop PC lines. We invited PC vendors to send one midrange and one high-end business-oriented Pentium-class PC. The result: 101

machines from 50 companies, lined up and ready for testing under the new 32-bit version of our industry-standard benchmark test program, Winstone 96.

The analysis found that even after the introduction of Intel's new Pentium Pro processors, PCs based on the "classic" Pentium and its competitors still have a lot to offer. That's particularly true when the Pentium machines are coupled with the new technology we're seeing in the subsystems and peripherals delivered in many of the new business machines. Among other technological advances, we found growing use of chip sets supporting Universal Serial Bus, BEDO (burst extended data out) DRAM memory modules, Fast/Wide SCSI-2

performance of systems running 16-bit Windows apps. Both are products of the Ziff-Davis Benchmark Operation (ZDBOp). Our Lab Notes column has information on how you can get a free copy of Winstone 32.

A final note: A roundup the size of our PC lines feature is always a challenge to the staff. This



Carol Venezia and Rich Fisco in a sea of PCs.

hard disk subsystems, and removable cartridge drives.

Just as exciting for our PCs team, under the direction of project leader Rich Fisco and associate editor Carol Venezia, was our first use of Winstone 32, our new 32-bit benchmark program. Winstone 32 is the new 32-bit companion to Ziff-Davis's Winstone 96, the standard for measuring the

time our burden was made even heavier by the recent death of our friend and fellow staffer Peter Bastide, after a long illness. A support technician in our New York lab, Peter worked at *PC Magazine* for eight years. Peter was a hard worker and a dedicated employee, and he had a great sense of humor. We'll all miss him.—*Jake Kirchner*

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CIRCLE 292 ON READER SERVICE CARD

UP FRONT

Inside

A 32-bit world.....4

Letters

The expandability issue....19

Trends

- ▶ The new PDAs
- ▶ Tech support heads for the Web
- ▶ Digital appliances
- ▶ Internet mail goes mobile.....31

Pipeline

Buying a new PC:
Decisions, decisions37

First Looks

- ▶ Director 5 for Windows
- ▶ Toshiba Tecra 720CDT
- ▶ Omnipost Analyzer
- ▶ Poser39

Second Looks

First Aid 95.....73

COLUMNISTS

Michael J. Miller

From the Editor-in-Chief.....29

Bill Machrone

The Web-as-Platform
Manifesto.....85

John C. Dvorak

Java: A Born Loser87
Inside Track.....89

Jim Seymour

PointCasting the Future?....93

Bill Howard

Frontiers of Benchmark
Testing.....95



HP DesignJet 755CM: Making big prints more affordable (page 48).

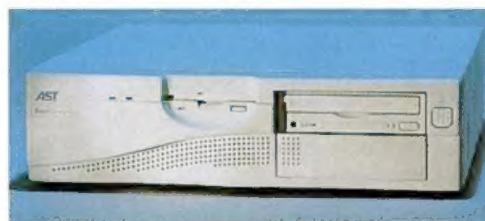
COVER PHOTOGRAPHY BY THOM O'DONNOR

COVER STORY

Pentium PCs

Pentium Classic: Still the One

BY ROBERT S. ANTHONY For mainstream business PC users, the Pentium Classic is the processor of choice, and for good reason. Not only does this CPU have



more than enough power to handle all of today's applications, but its performance keeps getting better because of new chip sets, memory technologies, and supporting components. And to top it all off, prices continue to decline. [PC Magazine Labs tests 101 Pentium-class desktops—from sub-\\$2,000 Pentium/120s to \\$5,000-plus, fully loaded Pentium/166-based machines—using both the core benchmark tests and the new 32-bit applications-based benchmark test program, ZD Winstone 32.....100](#)

ACMA Computers Inc.....108	HD Computer.....147	S.A.G. Electronics.....163
All Computer Warehouse.....126	Hertz Computer Corp.....148	Summit Micro Design.....163
AMAX Engineering Corp.....126	Hewlett-Packard Co.....148	Swan Technologies Corp.....164
AST Computer.....135	HiQuality Computer Systems.....149	Sys Technology Inc.....164
Austin Direct.....135	IBM Personal Computer Co.....150	Tagram System Corp.....164
Blue Star Marketing Inc.....136	Maximus Computers Inc.....150	Tangent Computer Inc.....166
CompuTrend Systems Inc.....136	Mega Computer Systems.....150	Tatung Co. of America.....166
Comtrade.....137	Memorex Telex Corp.....152	Unisys Corp.....166
CSS Laboratories Inc.....138	Micro Express.....152	Unitek Technology Inc.....170
Data Storage Marketing Inc.....138	Micron Electronics Inc.....152	USA Flex.....170
Dell Computer Corp.....139	MidWest Micro.....154	US Computer Direct.....170
Diamond Technologies Inc.....140	National Microcomputers Inc.....154	Vektron.....171
Digital Equipment Corp.....140	NEC Technologies Inc.....156	Editors' Choice.....103
DirectWave Inc.....141	NETIS Technologies Inc.....156	32-Bit Performance:
DTK Computer Inc.....144	Polywell Computers Inc.....156	Pentium vs. Pentium Pro.....104
EPS Technologies Inc.....144	Quantex Microsystems Inc.....158	How to Read the Service
Everex Systems Inc.....145	Reason Technology Inc.....158	& Reliability Boxes.....104
Gateway 2000 Inc.....146	Robotech Inc.....158	Performance Tests.....116
GST/Micro City Inc.....147	Royal Computer Inc.....163	Summary of Features.....135

FEATURES

Hardware

3-D Comes Alive

BY JAN OZER New 3-D-capable chips and Microsoft's Direct3D standard will bring arcade-quality games, 3-D spreadsheets, and VRML browsers to mainstream business PCs and even entry-level home systems. Expect to see a lot of these boards appearing before the end of the year, with application support soon to follow. In the meantime, we review seven of the latest high-end 2-D and ten OpenGL-compatible 3-D graphics accelerator cards. The 2-D cards are used for graphics, DTP, and image-editing applications; 3-D cards bring workstation-class performance to the PC for professional CAD, architectural renderings, and product modeling and animation.....172



THE HIGH AND MIGHTY179	Number Nine Imagine 128.....192
ATI Graphics Pro Turbo182	Number Nine Imagine 128 Series 2.....192
Diamond Stealth64 Video 3400XL.....182	Highlights175
ELSA Winner2000 Pro/X4.....184	Editors' Choice181
Hercules Terminator Professional.....189	How to Read the Suitability to Task Boxes182, 194
Matrox Millenium.....190	Summary of Features189

OpenGL 3-D ACCELERATOR CARDS192	Fujitsu Sapphire 3D Designer.....200
AccelGraphics AccelR8.....192	Oki TrianGL 16P.....202
Diamond FireGL.....194	Oki TrianGL 24P.....202
Dynamic Pictures V192 Graphics Accelerator Module.....194	OmniComp 3Demon SX88.....203
ELSA Gloria 8.....199	Symmetric Glyder 16.....203
Fujitsu Sapphire 2SX.....200	Performance Tests196
	A Peek into the 3-D Domain200
	Summary of Features202

Special Insert



Buying the PC That's Right for You

Are you in the market for a new desktop PC? In this special pullout section, we present comparative performance data from the 101 desktop PCs we tested for this issue. We also outline the features and components you can expect to find in midrange and high-end machines.....127

PC Magazine At Home

Do-It-Yourself Design



BY MICHAEL E. RYAN Thinking about remodeling your home or building a new one? In this story, we look at the five major Windows applications that will help you do just that, using 3-D home design and visualization tools. We also highlight a pair of specialty tools for designing kitchens and landscaping.....317

Home Design 3D 4.0320	Building a Better 3-D Home-Design Tool318
FloorPlan PLUS 3D.....322	Editors' Choice320
myHouse for Windows.....325	Reading the Report Cards322
Planix Home Designer 3D.....326	The Right Tool for the Right Job326
3D Home Architect.....331	

PC TECH

Windows 95's New Help System

BY NEIL J. RUBENKING Build a help system for your Windows 95 app: Five new tools give you all the help you need.....207

Tutor

BY JEFF PROSISE How Windows 95 stores long filenames, and what the implications are for end users.....217

Internet Tools

BY LUISA SIMONE Creating graphics images for the Web: Whether it's .GIF or JPEG, it's all about pixels, color, and compression.....221

Lab Notes*

BY MARK L. VAN NAME AND BILL CATCHINGS ZD Winstone 32—the new standard in 32-bit Windows performance testing.....229

Utilities*

BY MICHAEL J. MEFFORD Match your wits against the computer or a friend in a new classic game called Quod.....234

PC SOLUTIONS

User-to-User*

BY NEIL J. RUBENKING If you change views while renaming a file in Explorer, you may change the wrong filename; secondary batch files in DOS 7.....239

ASK OUR ADVISORS

Hardware

Text-to-speech devices for portable PCs; Solving LaserJet printing problems under Windows 95.....246

Operating Environments*

How DoubleSpace determines the compression ratio for your hard disk.....248

Word Processing

Dual page numbering in MS Word.....248

Spreadsheets*

Exporting all the worksheets in a Microsoft Excel workbook to a single text file.....254

Databases*

Add color coding to Visual FoxPro's editor; suppressing blanks in Paradox forms.....254

AFTER HOURS

Going Somewhere?

► Microsoft AutoMap Road Atlas 4.0.....335
► Road Trips.....335
► Rand McNally TripMaker 1996.....336
Muppet Mayhem.....336

Abort, Retry, Fail?

BY DON WILLMOTT.....344

NETWORK EDITION

Follows page 96

Cover Story

The New Ethernet.....NE1
► 10/100 NICS.....NE6
► 10-Mbps Switches.....NE11
► 100-Mbps Hubs.....NE11
► 100-Mbps Switches.....NE17

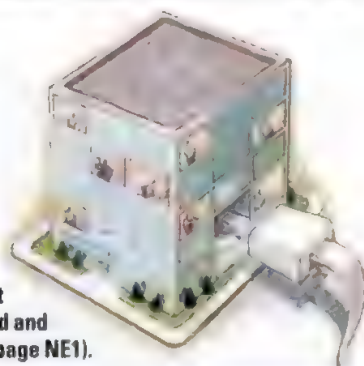
Multiple Access

BY ROBERT P. LIPSCHUTZ
Jump on the New Network.....NE17

First Looks

► Hughes DirecPC Access Kit, Model 40.....NE23
► Lotus Internotes Web Publisher 4.0.....NE24
► NetWare 4.1 SMP.....NE26

The new Ethernet: It's about more than just speed and bandwidth (page NE1).

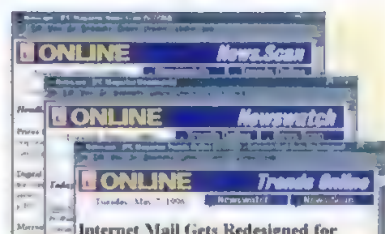


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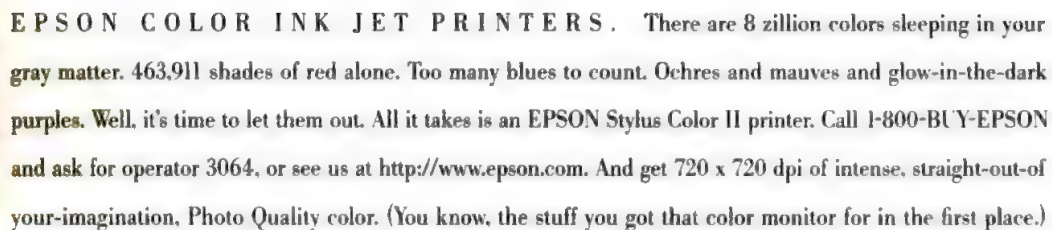
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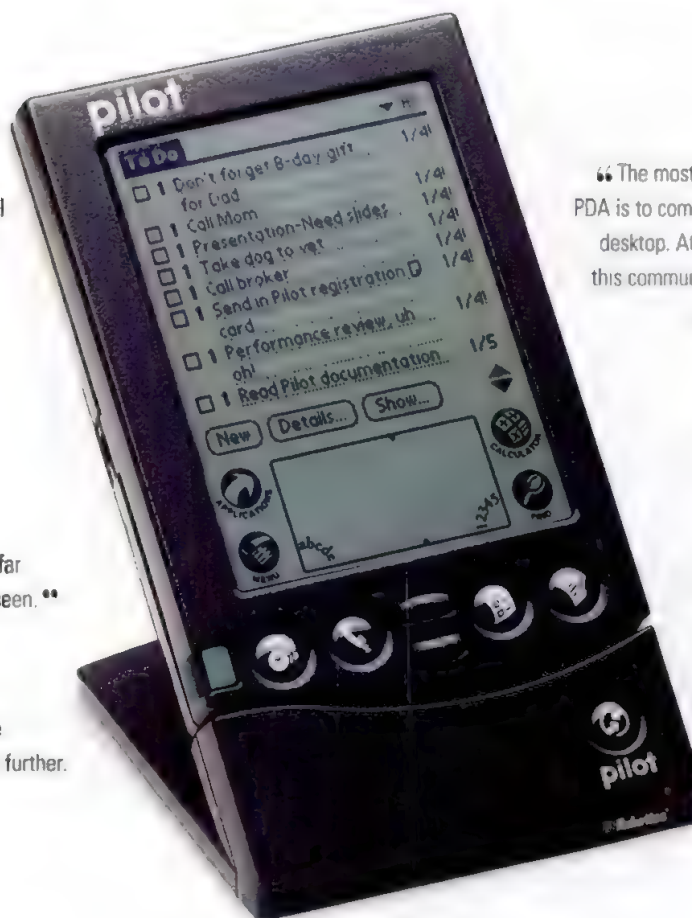
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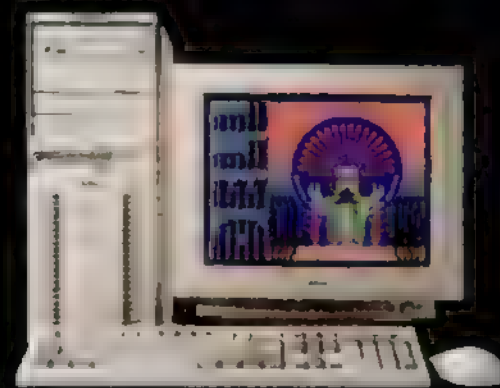
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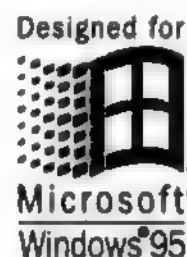
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Letters

REOPENING THE INVESTIGATION

Bill Howard's column "An Open and Shut Case" (March 12, 1996) comes as a surprise to me. One of the most important things to consider when purchasing a new computer is expandability. Why would a corporation or an individual want a PC that is "sealed for life" when technology is changing so rapidly? I like the flexibility of the computers on the market today and the option of choosing which company makes my peripherals. The challenge of finding new ways to make older computers more useful and productive has been healthy for shaping future technologies.

ROBERT GAMACHE
via the Internet

Howard's column really brought a smile to my face. The mere suggestion that the anticipated useful life of a system purchased today could be four years or more without an upgrade was comical. Only a high-end user could justify the \$5,000 to \$6,000 price tag that he suggested, and a high-end user won't be satisfied with any system purchased today for more than two years. I suggest that Howard dig into *PC Magazine's* archives and imagine himself using one of those high-end 386 systems reviewed four years ago.

JIM FORGER
via PC MagNet

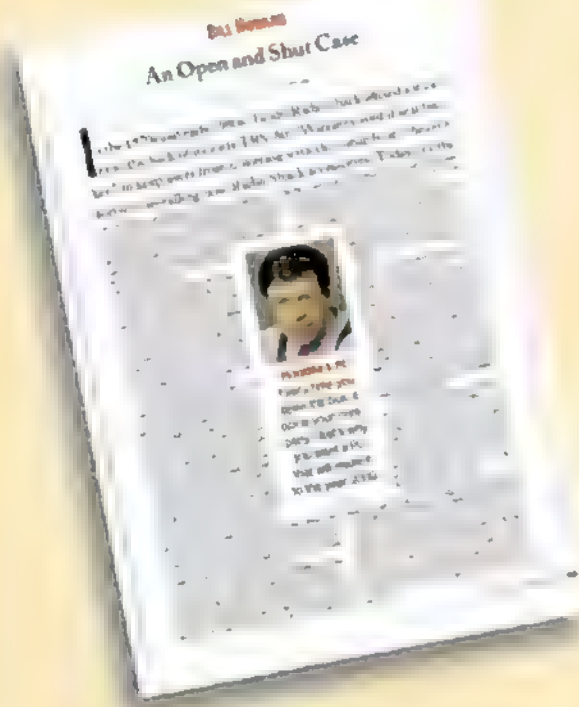
Howard's assumption that "every time you open the box, it costs your company at least \$100 to \$250" is misleading, unsupported, and a waste of money. Quality parts can often be installed in a brand-name computer in about 15 minutes with no problems. Howard's comments were fine for SOHO users or for companies undergoing a major overhaul, but anyone working in an established network will get a good return on an investment by buying middle-of-the-road equipment and upgrading as necessary.

KEITH ROWAND
via the Internet

Bill Howard is right on the money. Buy as much as you can, period. Get a 21-inch monitor, 32MB RAM, at least 4GB of data storage space, removable media, and a 10/100-megabit network card—but be sure to add a dual-channel SCSI or Universal Serial Bus (USB). Spend the money now and you can run the current crop of programs for many years to come. A little serious thought to the future will save you much in the long run.

CARL MUNDELIUS
via the Internet

Three new changes in PCs, coming during the next year or so, will affect all of our com-



*I like the option of choosing
which company makes
my peripherals.*

puters: high-density CD-ROMs (resulting in a new generation of applications), MPEG-compliant video boards, and the USB. Howard should know that there's no way a lid can be kept on technology for even two years.

GEORGE THYLITIN
via the Internet

TAG, YOU'RE IT

I've just read Robert Scott McDonald and Ken Collins's opinions concerning unfair attacks on Windows 95 (Letters, March 12, 1996). The computer press has praised Windows 95 as being the best thing since sliced bread. Now, some people are daring to challenge that. Although I personally like OS/2 better, I use Windows 95 because OS/2 doesn't support my old hardware as well. People have been bashing OS/2 for a while now, so it's about time Windows 95 got its fair share.

RYAN SCOTT
via the Internet

A UTILITY FOR THE REST OF US?

Thank you for finally doing an OS/2 utility in the Utilities section ("Warp Cabinet: An OS/2 Filer," February 20, 1996). It was a great surprise for those of us who are wary of Windows—in any flavor.

DAVID WEST
via the Internet

Thank you for the Warp Cabinet utility. OS/2's approach to disk management has always been a drawback, so the prospect of Warp Cabinet excited me. I like your ap-

proach but have noticed a problem: When selecting files for copying, moving, or deleting, the user doesn't have the ability to drag-select or fill-select—regular features in OS/2. It would be great if Warp Cabinet were composed of the best features from both Windows and OS/2.

DAVE EGLINTON
via PC MagNet

ADDING SOME STYLE

In response to John C. Dvorak's column about computers with color and style (Inside Track, February 20, 1996): It's about time. There have to be other people like me who are sick of wall-to-wall beige. Beige walls, beige work surfaces, beige computers, beige carpeting, and beige PCs. I'm surrounded by this most feeble of colors, so the Acer Aspire is a wonder to behold. Everyone in my office is knocked out by it.

BO RYAN
via PC MagNet

I might take some flak for this, but for the past few years I have been telling my friends that if companies made more interesting or colorful personal computers, more women would buy them. I certainly would. Design and color have kept me from buying a computer at home.

P.J. LANDIS
New Holland, Pennsylvania

I am surprised at the affection with which Dvorak views these new Acer boxes with the shotgun-blast holes. The Aspire locks you into an Acer CD-ROM-device upgrade path I want nothing to do with. What's wrong with a standard chassis design, like the one for home audio electronics, in which a "rack-mount" standard exists to benefit all? To trade off flexible architecture for flair in a PC box seems foolish.

MICHAEL J. ZAMBETTI, JR.
via PC MagNet

WEBBING IT

I enjoyed Jim Seymour's column "The Evolved Web. . .Someday" (February 20, 1996). I, too, have been frustrated by HTML tags littering files I've saved as text. Fortunately, I've discovered that the browser I most frequently use, Netscape Navigator, lets me save any Web page as a text file. When I read the file in my word processor, no HTML tags appear.

JONATHAN DENTCH
Pittsburgh, Pennsylvania

I have a particular frustration with browsers. I started surfing the Web with a text-only browser called Lynx. Later, I started using

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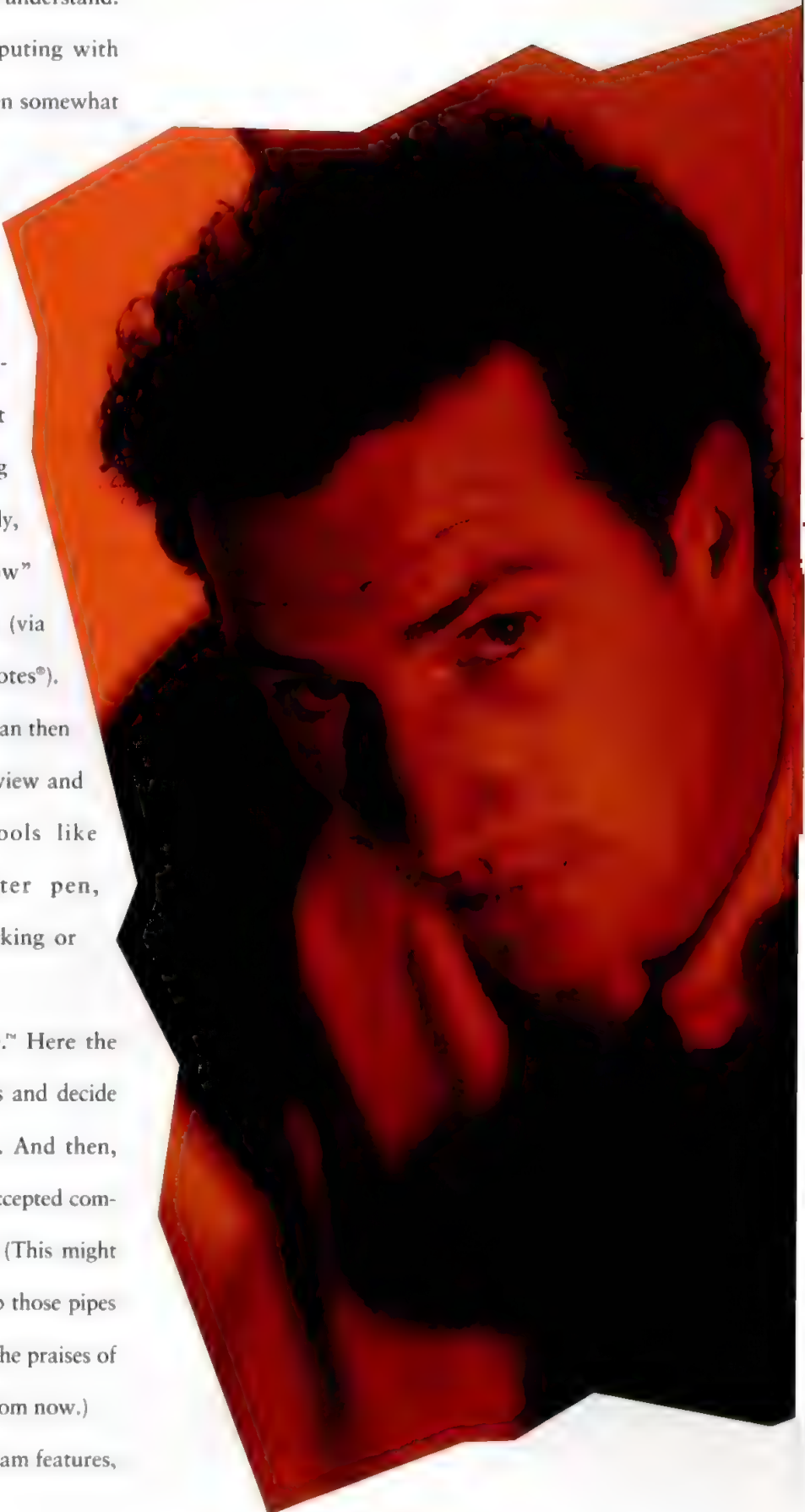


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Letters

CompuServe's NetLauncher, a full graphics browser. To my surprise, I have been forced to use both. Although I love graphics, Lynx has three features that I simply can't live without: speed, the ability to search any text document by keywords, and, most important, the ability to e-mail any text document to myself with a couple of keystrokes. I'm not aware of any full graphics browser that will let me do this.

BILL CONDON, JR.
via PC MagNet

WHEN I GROW UP

Bill Machrone's February 20, 1996, column, "Engineers: The Next Generation," is right on target. Often, something as simple as generating interest in a science like electronics can create interest in different careers.

DON LANDGRAF
via PC MagNet

TO EACH HIS OWN?

I strongly disagree with Michael J. Miller's opinions ("Cyber Censors," February 20, 1996) concerning legislation that seeks to prevent the improper use of the Internet. He writes that legislation banning indecency violates the right to free speech. I don't think that the First Amendment was ever intended to protect the distribution of indecent material. Radio and TV broadcasts are prohibited from airing similar material; the Internet, which reaches millions of people—including children—should be similarly regulated.

MILTON WONG
San Diego, California

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CORRECTIONS AND AMPLIFICATIONS

In our May 14, 1996, cover story, "The Ultimate Utility Guide," the review of ARCserve 6.0 for NetWare listed an incorrect phone number for Cheyenne Software. The correct phone number is 800-243-9462.

On page 316 of our review of Home PCs ("PowerHouse," April 23, 1996) the report card grades for Micron Electronics' P166 Home Pro MPC were listed incorrectly. The actual grades are A for *performance*, B for *sound*, A for *productivity*, and C for *setup*. The *edutainment* grade, B, is correct.

In his column, Miller writes, "We all have to accept that information—online or anywhere else—can be dangerous, whether it is about sex, politics, or weapons." I utterly and totally reject the idea that information is or can be dangerous. Ignorance is dangerous, not knowledge. Ignorance leads to stupid behavior, like bombing federal buildings, shooting doctors, or banning books. Irresponsible action is what hurts people, not access to information.

BRANDON BLACKMOOR
Portsmouth, Virginia

One of the wonderful things about the Internet is that it is almost impossible to censor. Politicians and the governments they represent would be taking on an enormous task with any such effort. There will always be people somewhere in the world who want to publish things that don't suit everybody. The only way to stop your children from seeing or reading unsuitable things on the Internet—or anywhere else, for that matter—is to survey what they are doing. Don't let your children play on the Internet alone if you want to control what they see.

BERT AMTEN
Vaxholm, Sweden

I object to the use of the term "family-oriented" to describe people who find sexually explicit material distasteful. This opinion no more makes one "family-oriented" than driving a Volvo does. The term implies that sexually explicit material and those who approve of it are "anti-family" (whatever that might mean). In truth, one has nothing to do with the other. Some people enjoy such material, some don't. Implying that a distaste for it or a refusal to use it somehow strengthens one's family bonds—or, conversely, that the use or enjoyment of it weakens them—is without basis in fact.

CHARLES B. CALVERT
via PC MagNet

MAKING ROOM FOR OTHERS

In your article about the new Pentium Pro processor ("Two Paths to Power," February 20, 1996), you state that this processor will work much better under a true 32-bit operating system. You then suggest running Windows NT—which is fine for people who can afford the operating system (plus the 64MB of RAM to go along with it) but not feasible for the rest of us. What about Linux, one of the

most powerful operating systems around?

TOM WOJCIACZYK
via the Internet

Being a longtime OS/2 user, I am frustrated by the lack of OS/2 coverage in *PC Magazine*. Any time the Pentium Pro is mentioned, it's all about Unix and Windows NT. I find that strange, given how slowly Windows NT is selling, plus the fact that OS/2 has had record sales for three months running. I'd like to believe that the computer industry is big enough for both OS/2 and Windows.

ETHAN ROYAL NICHOLAS
via the Internet

PC Magazine's review of the Pentium Pro PCs would have us all believe that Windows NT is the only 32-bit operating system capable of taking advantage of this chip. An acknowledgment of substantial performance improvements for both OS/2 Warp and Unix systems would have improved the review.

GILBERT PILI
via the Internet

WHOSE MISINFORMATION IS IT?

I was disappointed in the Trends article "Do You Believe Everything You Download?" (March 12, 1996). Your reference to a "rash of wildly speculative postings" minimizes CompuServe's own role in generating an environment that fosters such speculation. The episode really belongs to another familiar category: people attempting collectively to make sense of a situation for which responsible officials refuse to provide an explanation. Whether this occurs around the water cooler or over the Internet, people can hardly be faulted for engaging in speculation when nothing better is available.

J.A. BROWN
Washington, D.C.

A HAPPY ENDING

After I switched to Windows 95, my HP LaserJet 4 behaved abominably—refusing to print my favorite fonts, balking at more than an inch of a graphic, sometimes printing pure gibberish. Then I read and followed the directions in *Second Looks* ("Printer Amnesia with Windows 95 and HP's LaserJet," March 12, 1996) and printed a graphics-intensive flyer at about 70 percent coverage. I reinstalled my favorite fonts, and life is beautiful.

BARBY PULLIAM
El Dorado Hills, California

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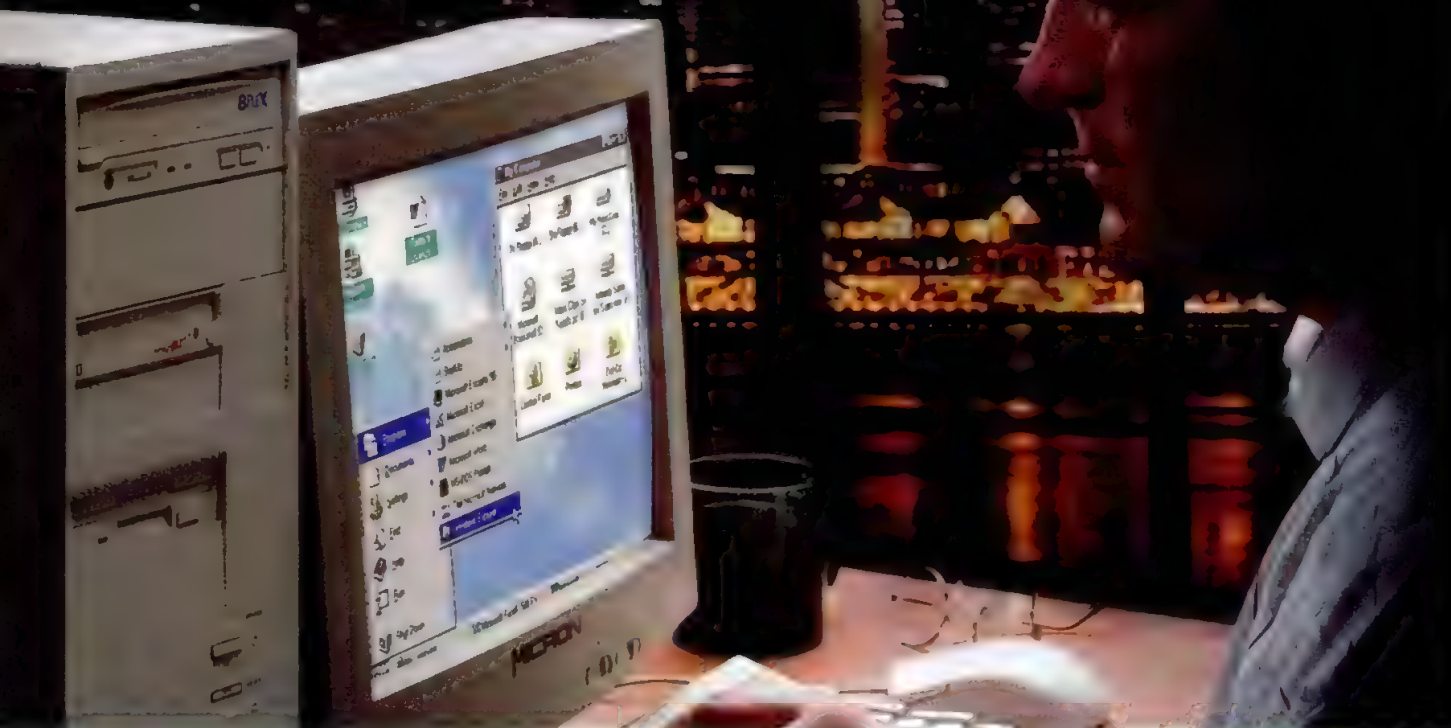
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Rebuilding Componentware

Remember component software? Those little pieces of code that were supposed to be the building blocks for creating custom applications? Well, as the little girl in *Poltergeist II* says, "They're baaack!" Fortunately, these spirits are meant to be friendlier than the

apparitions in the movie. Indeed, the aim behind component software is actually quite personal.

The concept is simple: Take the best parts of today's huge, standalone programs and combine them to create applications tailored to our individual needs. For instance, you might take a good spell-checker and combine it with your favorite presentation program or with your Web browser. It all sounded great when computer scientists—and then companies such as Apple, IBM, and Microsoft—started conjuring up these ghosts several years ago. But in practice, the efforts have resulted in a lot more hype than progress.

True, we now have a reasonable way to embed graphs and charts in word processing and desktop publishing documents and, more recently, a new way to collate documents created in multiple programs. And a bunch of Visual Basic programmers did get a number of objects—originally called VBXs, but now referred to as OCXs or as OLE controls—that can be hooked together. But for those of us who mostly use programs rather than write them, the promise of IBM's System Object Model (SOM), Microsoft's OLE, and Apple and IBM's support for OpenDoc remains just that: a promise. We're still a long way off from mix-and-match software.

Lots of us know how to use OLE code and how to use Windows to take advantage of it, but thus far, it hasn't been designed around a network (though this is supposed to change shortly). IBM has been including SOM in OS/2 for years and, a while back, introduced a distributed version called DSOM. IBM's REXX language makes it easy for a programmer to tie together applications, but there's a big difference between a conceptual framework and a solution accessible to end users. And we're a long way off from the time when the bulk of applications can be scripted easily. Apple has the scripting part down better, but its OpenDoc framework remains more concept than reality as well: The bulk of applications don't take advantage of it, and the operating system update that's really designed around OpenDoc has been delayed. Again.



RENAISSANCE
Component software has fallen far short of the mark. So why is it coming back now?

So far, component software has fallen far short of the mark. Maybe it was too ambitious, maybe it was too difficult to implement or use, or maybe end users really didn't want to mix and match software after all.

So why is it coming back now? The answer to this, like most every computer-related question these days, is the Internet. The big news is using browsers as platforms with Java applets, the tiny programs designed to be run within a browser and often embedded within an HTML page. Suddenly, everyone I talk to claims his application or her operating system is "Java-enabled," even if he or she hasn't the slightest clue what that means.

In some cases, we're discussing programming environments for creating Java code. Nothing new here. In other cases, such as in the new versions of Corel WordPerfect 7 and Ventura Publisher, we're talking about saving pages as Java applets to make use of a variety of fonts and more advanced layout options. But perhaps the most interesting development is what's happening to operating systems.

IBM seems to be in the lead, discussing how Merlin, the next version of OS/2, will

let you take a Java applet out of your browser and run it on the desktop as a standalone application. Not to be outdone, Microsoft is now saying Windows will be Java-enabled as well—though exactly what that means remains unclear.

Since Java applets are new, they're coming out of the starting gate with many of the latest innovations. Java applets are designed to be portable, and they work on any enabled browser or operating system. More important, most are engineered to be compact and networked and to work in combination with other applications using tools such as Netscape's JavaScript and Microsoft's Visual Basic.

Of course, Java isn't the only game in town. Microsoft is getting into the act with its own ActiveX components, a new version of OCXs designed for networks. And Apple is bound to find a way to make Java and OpenDoc coexist, as well as work with the company's scripting protocols.

Suddenly, component software is back. And you know what? This time, the pieces just might come together. □

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BENCHMARK TESTS

Toshiba Tecra 720CDT



The Toshiba Tecra 720CDT posted solid scores on our tests, but its strong suit is clearly innovative video and multimedia features. In raw performance, the Tecra 720CDT lagged behind other Pentium/133 notebooks (First Looks, April 9, 1996). For example, the Tecra 720CDT was competitive with the AST Ascentia P50 and Micron Millennia TransPort P133 on the ZD CPUmark processor tests and ZD Graphics WinMark 96

tests but trailed on ZD Winstone 96, with a score of 46. Equipped with a 6X CD-ROM drive, the Tecra 720CDT posted a significantly higher ZD CD-ROM WinMark 96 score than the Ascentia and Millennia attained with 4X drives.

To measure the performance of the Tecra 720CDT, we used ZD Winstone 96, Version 1.0, and ZD WinBench 96, Version 1.0. We used ZD WinDrain to measure battery life. The system we tested was equipped with 16MB of RAM.

Higher scores represent better performance.	ZD Winstone 96 Score	ZD Graphics WinMark 96 Mpixels/sec	ZD Disk WinMark 96 Score	ZD CPUmark ₁₆ Score	ZD CPUmark ₃₂ Score	ZD CD-ROM WinMark 96 Score	ZD WinDrain Hours:min
AST Ascentia P50 (April 9, 1996)	54	12.2	673	257	259	365	2:34
Micron Millennia TransPort P133 (April 9, 1996)	54	12.3	781	250	256	364	2:04
Toshiba Tecra 720CDT	46	12.7	608	251	247	598	1:53

of Windows NT 4.0 later this year.

In a world dominated by PC Card modems, the Tecra 720CDT's internal V.34 modem is a refreshing change. The system includes an external RJ-11 phone plug, telephone answering-machine software, and full-duplex features for conferencing. At the moment, the Tecra 720CDT is locked into a maximum data throughput of 28.8 Kbps.

Toshiba's tradition of building some of the most responsive keyboards continues with the Tecra 720CDT. With its 19-millimeter key spacing, typing on the Tecra 720CDT comes as close to using a desktop keyboard as you can get with a notebook. Toshiba's familiar pointing stick, AccuPoint, is similar to IBM's TrackPoint III but not as intuitive to use as a touch pad.

The system comes with all the expected amenities, including support for IrDA infrared file transfers and printing. But you'll have to settle for the 115-Kbps transfer rate, because the Tecra 720CDT does not yet support the latest 4-Mbps standard. There's a Type III PC Card slot that, in addition to supporting ZPV, can handle the newest

32-bit Card Bus notebook peripherals.

DOCK OF THE BAY

At \$799, Toshiba's PCI-based docking station, Dock V, is a must-have option for those who divide their time between the office and the road. There's room for three PCI and two ISA cards as well as a 5.25-inch, half-height bay. The unit

also includes a SelectBay module and a pair of Type II PC Card slots.

The system comes with an excellent instruction sheet for quick setup, an online help manual, and a get-acquainted demo program. Although short on productivity software, the Tecra more than compensates with an excellent set of multimedia-creation and -playback applications. The most intriguing are magiCDisc (for managing your CD-ROMs)

and Puma Technologies' TranXit 2, the premier IrDA interface (First Looks, June 11, 1996).

With a CPU running at warp speed, processor meltdown is always a possibility; there's a small fan next to the plugs for the external microphone, speakers, headphones, and the keyboard or mouse. The fan never turned on

during our tests, but the notebook's bottom did heat up and would have been uncomfortable to hold on one's lap.

All this cutting-edge technology added up to solid but not overwhelming performance on our benchmark tests. In terms of our CPUmark₁₆ and CPUmark₃₂ processor scores and Graphics WinMark 96 video result, the Tecra 720CDT was comparable to the Pentium/133-based AST Ascentia P50 and Micron Millennia TransPort. The Tecra 720CDT lagged behind both units on the Disk WinMark 96 and the all-important Winstone 96 tests.

For those who need to pinch pennies, there's the Tecra 500CDT, which trades the biggest and best for the merely advanced. It costs \$5,000 and features a Pentium/120 CPU, 256K of external cache, and a 12.1-inch display with a resolution of 800-by-600. A passive-matrix-based Tecra 500CDS will sell for \$4,000.

If you strive for the ultimate in video in a briefcase, look no further than the Tecra 720CDT.

Toshiba Tecra 720CDT. List price: With Pentium/133 CPU, 256K external cache, 16MB RAM, 1.3GB hard disk, 6X CD-ROM drive, 12.1-inch active-matrix display, \$6,299. Toshiba America Information Systems, Irvine, CA; 800-334-3445; <http://www.toshiba.com>. Circle 432 on reader service card.

Director 5

Continued from page 39

pabilities makes it a lot more powerful and flexible.

The Windows version of Director 5 runs on Windows 3.1, Windows 95, and Windows NT; there is also a Macintosh version. With Director 5, you can create 16- and 32-bit movies for Windows or the Macintosh or for publication on the World Wide Web.

Of course, Director 5 has basic support for Macromedia's Director-to-HTML converter, Afterburner, and the Shockwave plug-ins for Netscape Navigator 2.0 (see the sidebar "Director Add-Ons Can Turn the Web into a Silver Screen"). Both can be downloaded from Macromedia's Web site. With Afterburner, you can convert Director movies into highly interactive Web pages.

ALL THE WORLD'S A STAGE

In Director 5, you create multimedia movies by manipulating media elements, called *cast members*. The focal point for this activity is the Score window, where you create the sequences and synchronize the actions of your cast members. Director 5's Stage, the end user's screen, is where the action occurs.

To choreograph a sequence, we dragged cast members from the Cast window to the Score window and dropped them into one of the score's 48 sprite channels. There are other special channels to hold your palettes, scripts, sounds, and tempo changes.

This basic approach has not changed from Director 4, but fortunately, many of the operations that you perform with the score have been streamlined. Text cast members have been improved in this version. Large text is automatically anti-aliased relative to the background to smooth out jagged lines. In previous versions, aliasing made it difficult to display diagonal lines. Editable text is now bitmapped when the movie plays, and Macromedia has improved the program's text-importing capabilities. The graphics cast members can now



From June 24 to 28, go online to discuss Toshiba's Tecra 720CDT with senior product manager Philip Osako and Brian Nadel, a senior editor of PC Magazine. Type GO EDITOR on CompuServe.

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First Looks

include 24-bit graphics images.

One of the most interesting new features is called Onion Skinning. It allows the developer to position a ghosted image of other cast members beneath the current cast member to make subtle changes to an image or maintain consistent positioning of cast-member elements. In addition, you can now create bitmapped cast members as OLE objects and launch their native applications for editing from within Director 5.

CAST OF CHARACTERS

One of Director 5's most powerful new features is support for multiple casts. This simple feature opens new doors for developers. For example, you can place a central external cast on a file server as a central repository for group development, organize your cast members according to media type, or switch casts on the fly with the program's sophisticated scripting language, Lingo.

For example, switching casts on the fly allows you to create boilerplate movies for broad commercial appeal or customize a single movie for multiple languages.

Director 5 requires the use of Lingo coding for all but the simplest of movies. The Lingo language's syntax is reasonably intuitive, since it's based on the syntax of the English language. Director 5 includes dozens of new Lingo commands and a new script debugger.

Version 5 also introduces what Macromedia calls Xtras, which is the name for an add-on technique that's

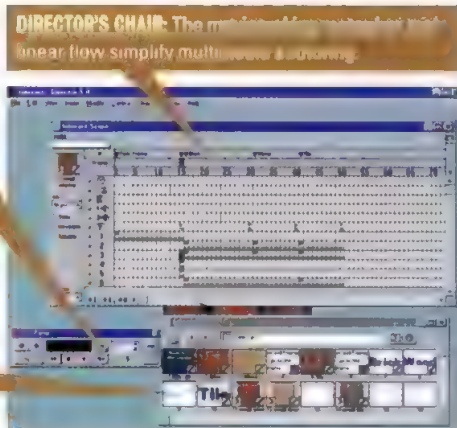
more powerful than the previous version's XObjects. The key is that Xtras can be written in the programming language C and

become add-on programs for Director 5, replete with their own interfaces. The basic product comes with some bundled Xtra modules, including Component Software's data-

mation techniques is unsurpassed, and its all-around moviemaking metaphor simplifies the creation of precisely timed and choreo-

SOUNDTRACK
Director 5's Control Panel lets you adjust all audio/visual parameters.

SNEAK PREVIEW
The Internal Cast Window shows thumbnails of scenes.



base, FileFlex.

Director 5 remains one of the most powerful products in its class. Its broad selection of ani-

graphed sequences.

As good as it is, Director 5 does not address the need for an alternative program-flow control

scheme. Although Director 5 works well for linear movies, it doesn't lend itself well to more complex applications with branching and dependencies, which are important features for computer-based training applications; the company's Authorware still dominates that field.

With Version 5, Director takes some significant evolutionary steps and becomes a much stronger tool for individual and group title development—whether the medium in question is a CD-ROM or the Web.

Director 5 for Windows. Estimated street price: \$850. Requires: 8MB RAM, 40MB hard disk space, Microsoft Windows 3.1, Windows 95, or Windows NT. Macromedia Inc., San Francisco, CA; 800-326-2128; fax, 415-626-0554; <http://www.macromedia.com>. Circle 429 on reader service card.

Director Add-Ons Can Turn The Web into a Silver Screen

For multimedia developers who have focused mainly on kiosks and CD-ROMs, the Web is a huge untapped distribution medium. Macromedia's Shockwave software, first introduced as an extension to Macromedia's Director 4, has revolutionized the Web by bringing animation, interactive elements, and sound to static HTML pages.

The Shockwave software is critical to Macromedia's Internet strategy, and the company plans to bundle the programs with all of its multimedia development tools. Shockwave software is also available free from Macromedia's Web site at <http://www.macromedia.com>.

Shockwave consists of two components. The first, Afterburner, is a utility that compresses Macromedia movies for distribution over the Web. Previously a standalone utility, Afterburner will use the Xtras technology in Director 5 to provide tighter integration with the authoring program's interface.

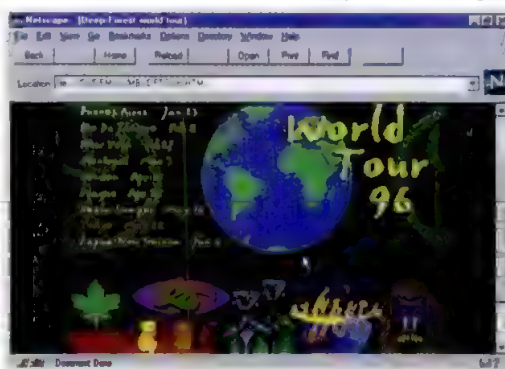
The other component is the Shockwave plug-ins for Netscape Navigator 2.0, which allow users to view movies created in Authorware, Director, or FreeHand. Macromedia has announced plans to develop versions for Microsoft Internet Explorer as well.

Many Web developers already use Director

and Afterburner to add animated logos and graphics to their sites. Other developers are using Director to build promotional movies. Some of the sites that use Shockwave for Director include those for CNN, Netscape Communications Corp., MTV, USA Today, and the Walt Disney Co.

Since movies that are compressed in

Afterburner must download completely before they can run, dial-up access-speed limitations have discouraged more widespread use of Director movies on the Internet. As the bandwidth increases, though, you're likely to see more and more "shocked" sites.—SWP



THE WEB LIVES: Sony Music Entertainment uses Shockwave to create promotional pages with vivid animation and stirring sounds.



From June 17 to 21, go online to download a demo version of Macromedia's Director 5 and discuss this multimedia development tool with product manager Kevin Ellis and Stephen Plain, a contributing editor of PC Magazine. Type GO EDITOR on CompuServe to join this session.

INTERNET UTILITIES

WebAnalyzer: The Finder of Lost Links

By John Morris

InContext Systems is an Internet life preserver for those who are drowning in a sea of World Wide Web-site details. The \$149 WebAnalyzer examines every node and can diagnose most common problems.

To analyze a site, all you need to do is enter its URL. The results, called Projects, are displayed in WebAnalyzer's three main windows: the WaveFront, Link, and File View.

WebAnalyzer's WaveFront view arranges the nodes as concentric rings showing the number of links away from the starting page. A series of icons identifies the nodes by MIME type: graphics, mailto: links, multimedia files, or text. You can right-click on specific nodes and select Properties to get more detailed information or view low-resolution thumbnails.

When you select a node in the WaveFront View, the Link View window to the left shows all the file's "in-links" and "out-links." At the bottom, File View lists every linked node by filename, type, size, date last modified, depth from the starting page, and number of links. You can sort on any of these headings.

WebAnalyzer had no trouble locating two out-links on a personal page to other pages that had not been posted. On larger sites, the program unearthed as many as 150 broken links. WebAnalyzer also contains customizable filters for viewing nodes based on file size or type or the status of the links—but not file date—to home in on problems.

When you create a new Project, WebAnalyzer caches all of the HTML documents and thumbnails to your hard disk; this can take up from 1MB to 15MB, depending on the site. Unlike Netscape Navigator, WebAnalyzer doesn't allow you to limit total caching, but you can limit downloads based on file type



RING OF FIRE: WebAnalyzer's views show how far a page is from the home page and let you filter based on key criteria.

(audio, pictures, or video). On a 486DX/33-based PC with 16MB of RAM and a shared T1 connection, it took from a few minutes to

45 minutes to download individual sites.

Once you find out what's wrong with the site, WebAnalyzer allows you to launch your browser and automatically jump to the page, open an HTML editor to view the underlying code, or generate a report. And if you've got the disk space, you can mirror the entire site for browsing off-line.

During evaluation, we found out that WebAnalyzer doesn't support aliased URLs. As a re-

sult, we had trouble using WebAnalyzer to analyze some sites, including PC Magazine Online. A maintenance release, which should be available at the company's Web site (<http://www.incontext.com>) by the time you read this, will add alias support, reduce system crashes, and support high-resolution thumbnail images.

WebAnalyzer is an ambitious and promising effort that combines Web management with off-line browsing.

WebAnalyzer. List price: \$149. Requires: 8MB RAM (12MB recommended), 3MB hard disk space, Microsoft Windows 95. InContext Systems, Toronto, Ontario, Canada; 800-263-0127, 416-922-0087; <http://www.incontext.com>. Circle 430 on reader service card.

INTERNET SOFTWARE

Corel Web.Data Delivers Instant Internet Databases

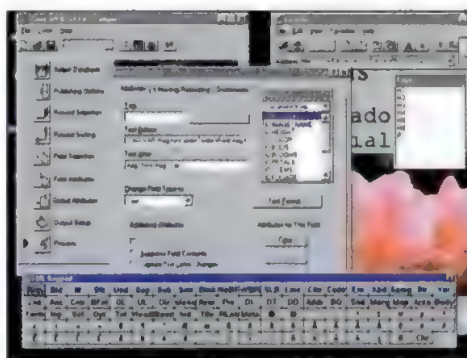
By Richard Dragan

With just a few minutes of work, Corel Web.Data 1.0 can transform a Web page into a data-rich source of information. To get the most out of this \$149 product, you'll need to know the basics of HTML, but Web.Data's simple, elegant interface lets even Internet novices publish their data in a hurry.

The program's organizing concept is the Recipe, which is a template for producing a specific type of Web page. There are nine buttons, one for each tool used to create the Recipes. The process resembles that used by many database reporting tools, with a few extra steps for putting your data online.

Web.Data offers excellent connectivity to a wide variety of

databases, including Access 2.0, dBase 5.0, FoxPro 3.0, Oracle, and Paradox 5.0, as well as Excel 5.0 and Lotus 1-2-3 spreadsheets; additional database connections are available through ODBC drivers. It's easy to create joins among tables, and you can add



HTML SHORTCUTS: Set field attributes easily in Web.Data using its HTML Keypad tool, which allows you to apply more than 90 HTML codes.

calculated fields based on other values in your tables.

Start by choosing the page format: HTML 3.0, Netscape Navigator, or Microsoft Internet Explorer. Next, select which records

and fields to display. Web.Data lets you build queries and sort records without worrying about the intricacies of database design.

Web.Data's Field Attributes tool lets you choose a field and control how it will appear. For best results, you'll need to know basic HTML coding, but Web.Data's HTML Keypad tool lets you add common tags without typing them.

One indispensable feature here is the ability to display graphics linked to your Web pages effortlessly. If you refer to an image by filename in a table, Web.Data will display it, whether it is stored locally or on a remote URL. Common graphics formats such as .GIF and JPEG are supported. For more advanced formatting, Web.Data also supports the use of dictionaries that let you translate values.

With its simple logical interface and strong connectivity, Web.Data may well earn a place in your arsenal of Web-design utilities.

Corel Web.Data 1.0. List price: \$149. Requires: 8MB RAM, 20MB hard disk space, Microsoft Windows 95 or Windows NT 3.51. Corel Corp., Ottawa, Ontario, Canada; 800-728-3733, 613-761-9176; <http://www.corel.com>. Circle 431 on reader service card.

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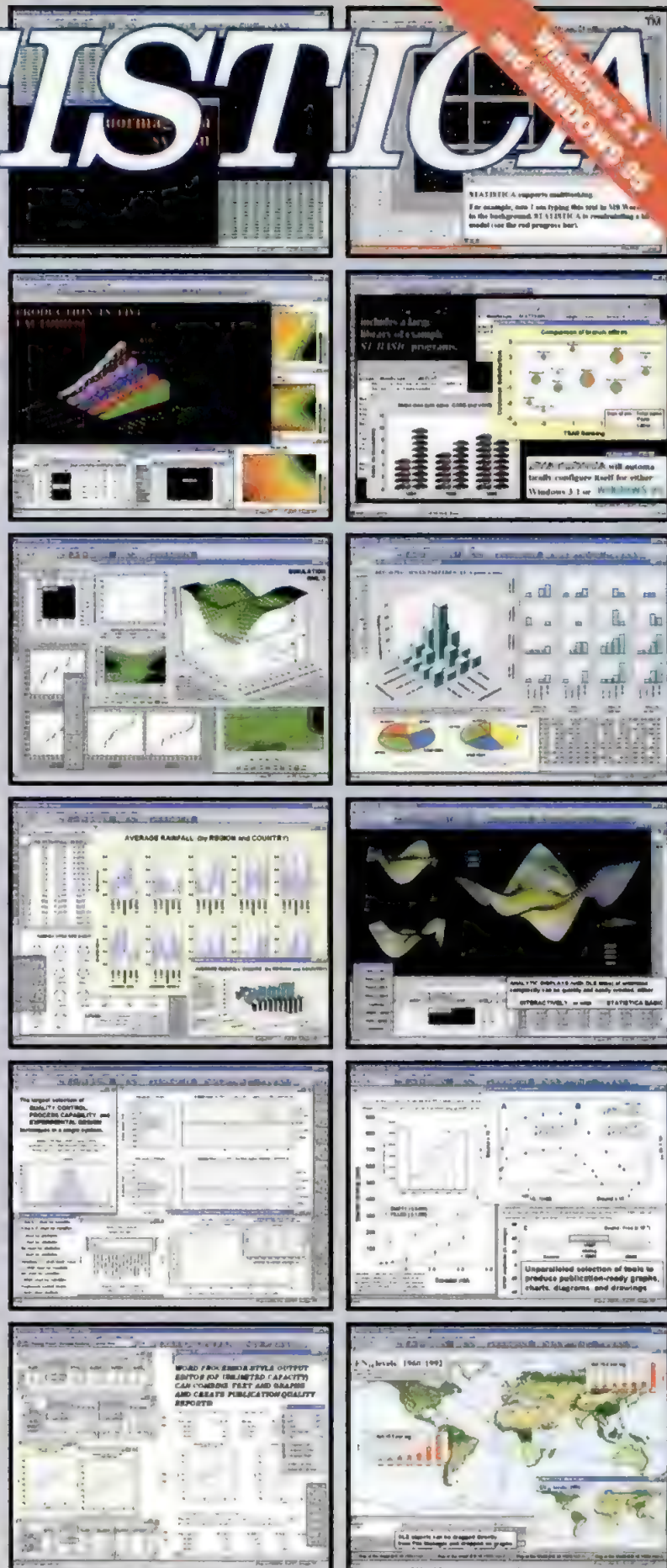
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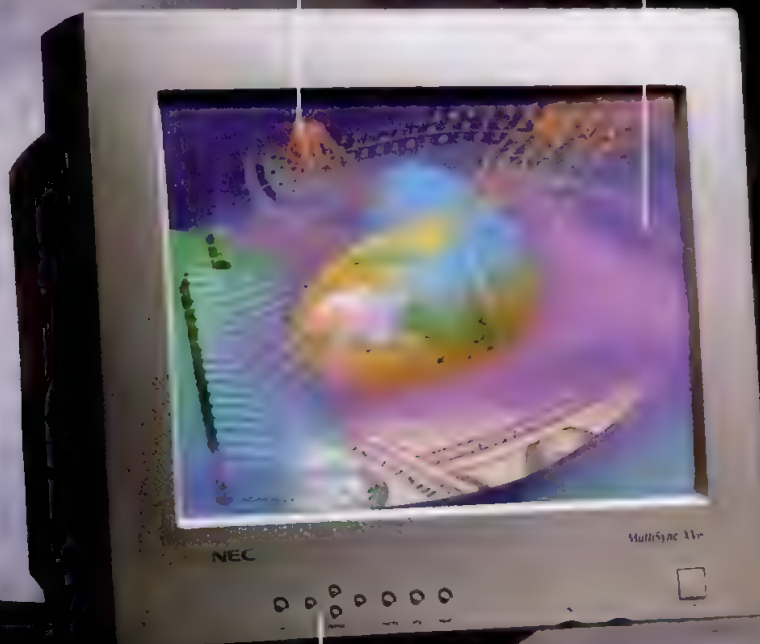
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PRINTERS

HP DesignJet 755CM: The Long And Short of Poster Printing

By Daniel Grotta and Sally Wiener Grotta

The \$11,995 HP DesignJet 755CM, a large-format ink jet printer, takes a giant step toward making big prints and posters more affordable and accessible but fails to make the creation of billboard and poster-size prints an everyday output choice for most desktop users.

Make no mistake, this printer is not for the desktop—anyone's desktop. At 135 pounds and with the floor-space requirements of a table saw, the DesignJet is about as big and heavy as PC printers get. Fortunately, this printer, which is capable of producing 3-by-9-foot posters at 300 dots per inch (dpi) for color or 600 dpi for monochrome output, rolls easily on lockable wheels.

Even so, many will have difficulty finding enough space for this 54-by-27-by-47-inch behemoth. Placement of the printer's parallel port and power cables at opposite ends of the unit doesn't help either; many will

find it slightly awkward and time-consuming to find a comfortable location for the DesignJet.

The process of assembling and setting up the DesignJet is neither a solo job nor a job for novices. It takes two physically fit people to bolt the DesignJet together, a task made difficult by the lack of complete written instructions or a setup booklet; HP provides a somewhat ambiguous illustrated assembly sheet.

After reading the documentation, we installed ink cartridges with the printer turned on; otherwise, the ink jets might fail prematurely. This is not an insignificant consideration for black cartridges that cost \$32.95 and color cartridges that cost \$39.95. All told, it'll cost you about \$7 per page to print with the DesignJet.

The Achilles heel remains the



DESKTOP—NOT: Nearly 5 feet long, the HP DesignJet 755CM is the monster of the ink jet printer market. Prints from the DesignJet 755CM are detailed with crisp lines and rich colors (inset).

ink's chemistry. Although HP chemists have improved its durability, even the best image will fade in about a year unless you put it in a frame with UV-protected glass or laminate it with a special coating.

Every time you install new ink cartridges, the DesignJet auto-

matically performs an alignment check across the unit's entire 36-inch carriage width. Each cartridge has a window showing how much ink remains, and the printer detects when it's empty.

Unlike the cartridges in some other large-format ink jet printers, HP's black cartridge has the same capacity as its cyan, magenta, and yellow cartridges, and therefore may need more frequent replacement. HP neither sells oversize cartridges nor includes a provision for refilling the cartridges; third parties sell refill kits and large-capacity ink wells, however.

EASY INFO

The DesignJet's LCD control panel displays easy-to-follow, step-by-step English (or Spanish) instructions for a variety of functions, such as setting up the correct interface (parallel, serial, or 10Base-T Ethernet), loading paper, selecting the media type, setting margins, and printing a demo, among others. It even tells you such things as when to raise or lower the pressure handle or straighten the paper. The printer-control buttons are large

Magic Stretch Canvas: Instant Art

Rexam's Magic Artist Stretch Canvas is a creative alternative to printing on paper. The ink jet-ready canvas features a bright, shiny white textured surface specifically designed to interact with inks from printers such as the DesignJet 755CM. The look and feel are so much like those of real canvas that you may be tempted to give up your oil paints and brushes.

The canvas comes in 36-inch-wide rolls that are either 10 or 35 feet long, as well as a variety of single-sheet sizes. Unless you produce oversize prints (those that are longer than 48 inches), we suggest forgoing the roll's economy and buying the single sheets. That's because the canvas is 20 mils thick—too heavy to be cut by the DesignJet 755CM's built-in knife. Another problem with the canvas is the slight curl produced when the substrate is wound around the printer's 2-inch spindle.

Unfortunately, no large ink jet has the canvas media's characteristics stored in its media profiles. With some experimentation during our evaluation, we found that either coated glossy paper or coated glossy film selections produced the best results.

The inks dry instantly, so there's little chance for bleeding. Even at a resolution of 300 dots per inch, one can discern a tight dot pattern, even on the canvas' absorbent and irregular surface.

The effect produced by a suitable computer-generated illustration or photograph printed on Magic Artist Stretch Canvas is warm and beautiful and would be at home in any art gallery.

Magic Artist Stretch Canvas. List price: 35-foot roll, \$330; 10-foot roll, \$94. Rexam Graphics, South Hadley, MA; 800-628-8604. Circle 406 on reader service card.



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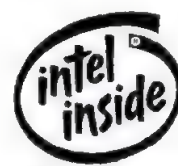
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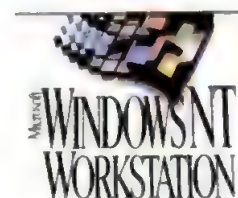
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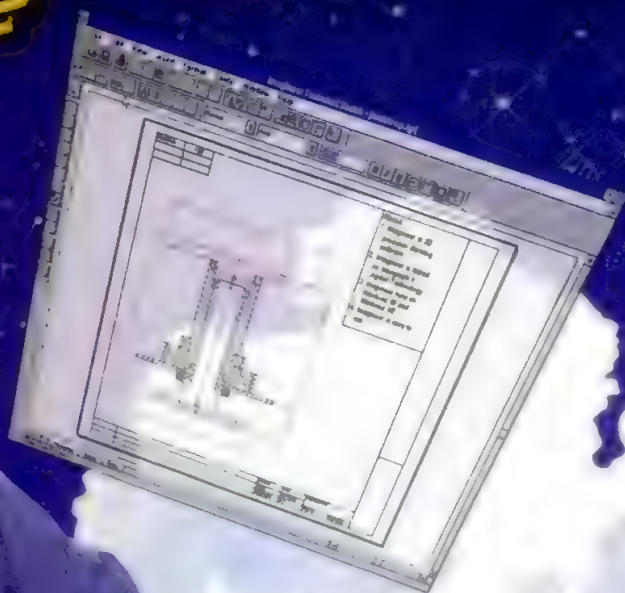


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INTERGRAPH
SOFTWARE SOLUTIONS

and well marked, allowing the user to select color or monochrome and best, normal, or fast printing mode.

Paper handling for the DesignJet is sophisticated. The printer doles out paper from a long roll and after printing, the DesignJet trims it to the correct length; alternatively, you can use single sheets. Correctly loading paper into the DesignJet takes some practice, but once we figured out which way the paper should roll and how to cut the feeding edge properly on the unmarked recessed guide, we became quite adept at it. Because inserting a paper roll into the take-up spindle can be tedious and time-consuming, we suggest buying extra spindles (about \$100 each) and preloading your rolls for faster media changes.

The DesignJet accepts a wide variety of roll stock or single sheets: high-gloss and semigloss coated stock, translucent and transparent film, matte paper, bond paper, tracing paper, and even vellum paper. There are even less-mainstream alternatives (see the sidebar "Magic Stretch Canvas: Instant Art") that others provide. It's important to select the correct medium on the DesignJet's display and the appropriate printer driver. If not, the printer will apply too little or too much ink.

HP provides drivers for Windows 3.x, AutoCAD, and the Macintosh but not for Windows 95 or Windows NT. The DesignJet can be installed as a stand-alone device or as a network printer. We had no problem setting it up to run under Windows for Workgroups. HP's Windows interface is utilitarian and uncomplicated, with automatic or manual color controls (vivid color, match screen, or no adjustment) as well as three choices of halftoning screens (scatter, pattern, or cluster).

To use HP's manual color controls, you must first roughly calibrate your monitor by eyeballing bars of color and using scroll bars to try to make them appear similar. The DesignJet got off to a

rough start; because of a bad set of ink cartridges, our first batch of prints tended toward the magenta side of the spectrum. Subsequent prints with new cartridges produced consistent high-quality images across the 3- by 6-foot posters we printed. On the downside, vector files tended to be oversaturated with the default settings; we got better results when we turned off HP's color management.

The DesignJet comes equipped with PostScript and 71MB of memory (68MB is available for printing); you'll need a machine with at least 20MB of memory, although HP's minimum specification is 4MB. For the frugal, HP sells the \$7,500 DesignJet 750C, which includes 4MB of RAM but no PostScript support.

SPEED IS OF THE ESSENCE

The DesignJet is remarkably fast: Our 67.7MB test TIFF file took 11 minutes 56 seconds to print, which translates to a rate of about 2 inches per minute. The unit printed vector images at a similar clip.

Despite being scaled up by a factor of more than 40, the printed images were consistently crisp and colorful, with clear, finely defined type and lines. Gradients were smooth and almost seamless, with little or no banding; dithering and dot patterns were unobtrusive. Only when you get close or magnify the output do you see artifacts. Even at 200 dpi, TIFF photo files printed with excellent detail and smoothness.

Although cost and size constraints limit the DesignJet 755CM to a small audience, this is a first-class piece of technology capable of producing impressive large prints and posters that in some cases can give presentations more impact than even big-screen projections could.

HP DesignJet 755CM. List price: With 71MB of RAM, \$11,995. Requires: 4MB RAM, Microsoft Windows 3.x or later. Hewlett-Packard Co., Palo Alto, CA; 800-354-7622; <http://www.hp.com>. Circle 405 on reader service card.

PRINTING SOFTWARE

PosterWorks: Graphics Images Living Large

By Arie Moller

If a picture is worth a thousand words, how many sentences is a billboard worth? If you wanted to print that billboard's worth of words, until recently you were limited to using platforms such as the Apple Macintosh or the Indigo workstation.

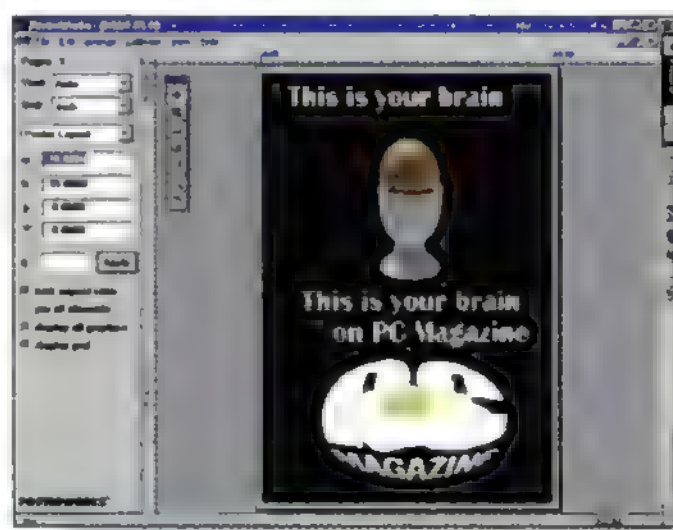
S. H. Pierce & Co. brings large-format printing capabilities—of up to 10,000 square feet—to the

duce memory overhead, PosterWorks uses a low-resolution copy of the original that can be resized and moved for the layout window. The program creates an internal pointer for the full-resolution original when you're ready to print.

Printing options include monochrome, color, or four-color separation (cyan, magenta, yellow, and black). Besides saving your layout as a PostScript file, PosterWorks

lets you export the layout to a standard BureauFile format.

Although it's not designed to replace illustration programs, PosterWorks provides some rudimentary manipulation tools, such as rotation and cropping. To make final color adjustments, PosterWorks provides direct control of color-balance correction



FUNCTIONAL FRONT END: PosterWorks' interface provides tools for producing posters.

PC world with its \$495 PosterWorks 4.0 for Windows. Based on 16-bit code, it is essentially a rewritten version of the original Mac program. The interface layout is standard fare, with pull-down menus on the top, a graphic-layout window to the left, and a layout-details window to the right.

When starting a new project, you have two choices: You can either enter all the necessary layout options manually or be walked through the process using the built-in layout assistant, which describes the steps in eight languages ranging from Hebrew to Japanese. Be warned that once you answer a question in the assistant, there is no way to change your mind; you must restart the assistant and start from scratch.

Once your printer and basic layout information are entered, it's time to place the poster's elements. PosterWorks supports several file formats, including TIFF, Scitex CT, and PostScript's .EPS. To re-

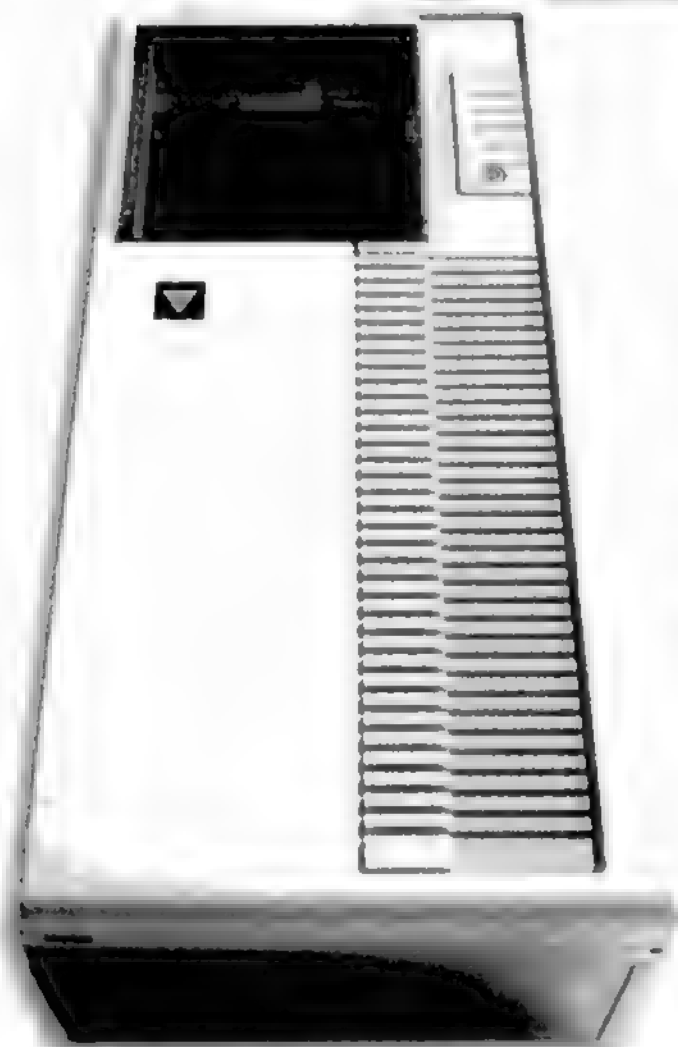
curves for cyan, magenta, and yellow using a spline-curve graph.

We found several areas that could stand improvement. First is the lack of a context-sensitive help file. PosterWorks' 340-page printed manual is adequate, but the program doesn't provide the easy access to the information that an online help engine does. In addition, you can't copy and paste or drag and drop objects into PosterWorks from other programs via the Windows Clipboard.

PosterWorks is geared toward professional graphics artists who need large prints, but its results demand a larger audience.

PosterWorks 4.0 for Windows. List price: \$495. Requires: 5MB RAM (8MB recommended), 3MB hard disk space (20MB recommended), Microsoft Windows 3.1 or Windows 95. S. H. Pierce & Co., Cambridge, MA; 617-338-2222; fax, 617-338-2223; <http://www.posterworks.com>. Circle 407 on reader service card.

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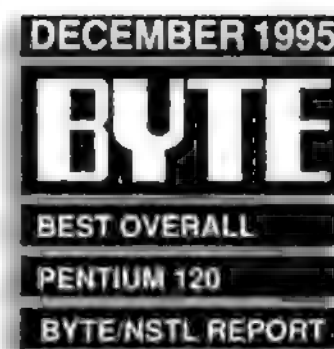
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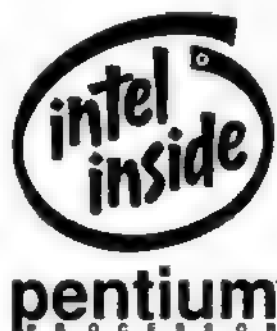
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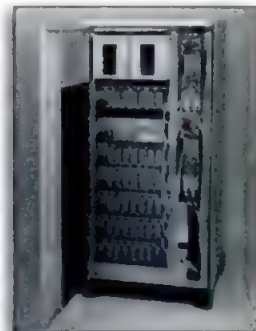
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ANIMATION

Fractal Poser Sets Your Images in Motion

By Luisa Simone

Fractal Design Corp.'s \$199 Poser is a one-trick pony: It produces a 3-D model of the human figure that can be manipulated into both natural and fantastic poses. And it is extremely good at this single task.

The 3-D figure you work with can appear in Poser's working windows as a silhouette, a simple outline, a wireframe, or a flat, shaded solid object. Regardless of the view you choose, the program's eight tools give you total control over the model. You can directly select and then rotate, scale, twist, size, and even reshape body parts on the fly.

CREATIVITY ABOUNDS

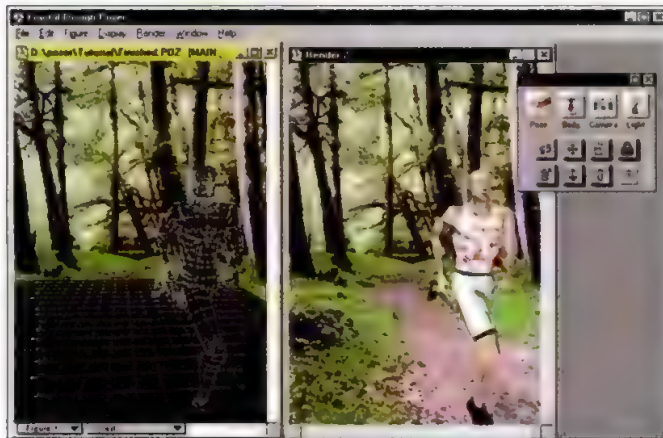
Poser's freedom of expression puts you in the driver's seat. We were able to increase the size of a male model's hands to mimic Michelangelo's statue of David and taper the waist of a female model to reproduce the hourglass figures popular in the 1940s.

Poser makes it easy for even 3-D neophytes to manipulate the figures by simplifying the geometry and building native intelligence into the models. For example, body parts are related to one another hierarchically. In this anklebone-connected-to-the-shinbone system, you simply use the Translate tool to drag the figure's hand to a new position. The forearm, upper arm, and torso follow along naturally.

Anyone who has ever drawn a figure from life understands that the pose is only one aspect of the composition. One's vantage point influences perspective, and lighting influences surface modeling. So in addition to Pose mode, the program

supplies a trio of working modes that allows you to manipulate the body as a single entity within the workspace, change the camera angle or viewpoint, and configure

With all this going on, you'd expect Poser to take forever to build such complex scenes, but the Fast Tracking option allows the program to drop back to a



BUMP AND GRIND: Poser allows you to render a 3-D model, complete with bump and texture maps, against an imported background. The ground-plane guidelines in the left window help you reposition the figure to match the perspective in the background image.

three lights to create highlights and shadows.

If you don't want to create an entire 3-D scene from scratch, you can quickly assemble one from the program's Library palette. There are presets for body types, camera positions, lighting conditions, and

bounding-box view of the model (rather than a fully delineated wireframe) when moving a figure. It's slightly less accurate, but the option provides real-time feedback on limb position. And you can incorporate multiple figures into a scene (without increasing demands on system resources) by successively pasting each figure onto the background.

When the time comes to composite your figure into a scene, you have several options. You can import a bitmapped background image in .BMP or TIFF format. Poser maintains the background as a separate plane so that you can use vector tools, such as the camera position or spatial guidelines (for example, a ground plane and vanishing points), to align the view of the figure with the perspective of the background image.

If you choose, you can render your figure along with the imported bitmapped image or just as easily export it as a .BMP or TIFF file for use with a raster-paint program. Poser automatically writes 32-bit TIFF files that

contain an 8-bit alpha-channel mask along with the 24-bit RGB data to ease compositing the figure into another raster image.

There's a bonus for those who regularly work with vector programs that can interpret 3-D data, because they can use Poser's .RIB (Pixar Renderman format) or .DXF formats. The export feature is not perfect, because we found that the hierarchical relationship among body parts is lost when exporting vector models. This means that you can't further fine-tune the pose in another 3-D animation, CAD, or modeling program.

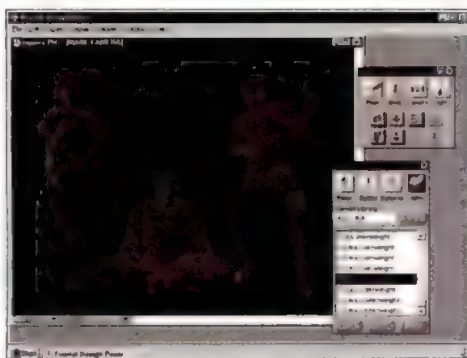
When you render a Poser model, you can apply both bump maps (to contour muscles) and texture maps (to add tight-fitting clothing or surface patterns). Despite these advanced features, the final rendered image is subject to certain inherent limitations. The simplified geometry is responsible for the program's speedy rendering times, but it is also responsible for the occasional artifacts—such as sharp corners on what should be rounded surfaces. Likewise, bump and texture maps can never produce fine details such as expressive features or loose, flowing hair.

WORKING WITH POSER

Poser was not designed to produce fully realized images. If you want absolute control over geometry, mapping, and rendering to produce a final version of a figure, you'll be disappointed with Poser's deliberate limitations. Using Poser in the way its designers intended means that you'll be generating reference models that will be further enhanced in paint and illustration programs.

Starting with such a good reference point almost guarantees that your figures will look as if they were drawn from life, not rendered in a computer—whether you're breathing life into a storefront mannequin or a decathlete.

Fractal Poser. List price: \$199. Requires: 8MB RAM, 5MB hard disk space, Microsoft Windows 95. Fractal Design Corp., Aptos, CA; 800-297-2665, 408-688-5300; <http://www.fractal.com>. Circle 426 on reader service card.



LIBRARY CARD: Using the libraries of predefined poses and body types, you can quickly create mannequins in different positions.

poses. So, for example, generating a three-quarters-left top view of a slightly overweight male model in the Shuto Uko martial-arts pose in springtime light is as simple as changing formatting commands.

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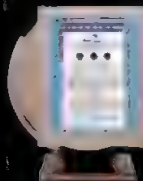


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MONITORS

Nokia Multigraph 447Xav Delivers Sight and Sound

By Steve Buehler

Nokia Display Products enters the booming multimedia-monitor market with the \$999 Nokia Multigraph 447Xav. Drawing on the company's expertise in manufacturing European sound and video equipment, this monitor, which measures 17 inches diagonally and has a 15.7-inch viewable area, features several built-in components, including speakers, a subwoofer, and a microphone.

The 447Xav is positioned in the middle of Nokia's current line of 17-inch multimedia monitors. The 447Xav adds speakers to the nonmultimedia \$899 447Xi but lacks the built-in camera of the top-of-the-line \$1,499 447K. Our testing showed the sound quality to be above average for a multimedia monitor, but the 447Xav's performance was slightly below Nokia's normally high standards.

Like many other multimedia monitors, the 447Xav has a pair of 2-watt speakers, located at the lower-front corners of the chassis. Nokia also adds a 4-watt omnidirectional subwoofer in the base of the monitor case. This combination provides better all-around frequency response compared with that of the competition.

The Sony Trinitron cathode-ray tube supports resolutions of up to 1,600-by-1,200 at 72 Hz, and Nokia's virtual-display feature, Full Screen, lets you adjust the image right up to the edges of the monitor's viewing area. Other adjustments are made through an on-screen control panel. The monitor supports Plug and Play and ACCESS.bus.

On ZD Labs' MicroVision SpotSeeker III tests, the 447Xav was a middle-of-the-pack performer in comparison with the average results of our last 17-inch monitor roundup ("Bigger Windows," September 12, 1995). Good Spatial Uniformity test

scores were offset by lower-than-average (although still acceptable) Pincushioning test scores. The below-average MTF scores indicated less usable brightness than that exhibited by other monitors. The 447Xav passed all of our emissions tests.

Speaker tests with our Audio



Precision AP-1 test-bed showed a frequency range of 91 to 20,000 Hz +/-6 dB, which is excellent for

SIGHT AND SOUND: The Nokia Multigraph 447Xav excels at both visual and audio reproduction.

a multimedia monitor, although its total harmonic distortion was a bit high.

The 447Xav's subwoofer did a good job of reproducing low tones. Although there was some clipping and distortion at mid-to-high volumes, the speakers actually produced great sound when the design limitations of having magnetic-field isolation and acoustic separation placed on a multimedia monitor are taken into account. The unit's speakers won't match a set of \$150 external speakers, but for ordinary everyday use, the audio system produced vivid and natural sound.

The Nokia Multigraph 447Xav is an effective mid- to upper-range multimedia business monitor.

Nokia Multigraph 447Xav. List price: \$999. Nokia Display Products Inc., Sausalito, CA; 800-296-6542, 415-331-6622; <http://www.intltech.com/nokia>. Circle 425 on reader service card.

BENCHMARK TESTS

Nokia Multigraph 447Xav



The Nokia Multigraph 447Xav's performance was mediocre, from below-average marks on our MTF and Pincushioning tests to an average Color Tracking score. We tested it using a MicroVision SpotSeeker III.

	Average MTF	Color Tracking	Spatial Uniformity	Pincushioning	RMS Misconvergence
▲ Higher scores represent better performance.	Percent	Percent	Percent	mm	mm
▼ Lower scores represent better performance	▲	▲	▲	▼	▼
Nokia Multigraph 447Xav	52	92	3.89	0.80	0.13
Average 17-inch monitor (Sept. 12, 1995)	80	93	4.75	0.39	0.13

UTILITIES

Dimension 4: What Time Is It, Really?

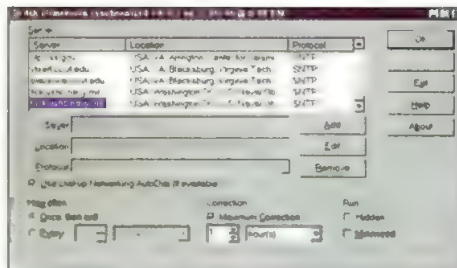
By Barry Simon

If you have several PCs, you may have noticed that they rarely show exactly the same time. One will lose a few seconds

a day while another will pick up a few seconds a day. That doesn't sound like much, but after a couple of months, your PCs can become separated by several minutes. Whether you're compulsive about what time it really is or want all your PC clocks to be synchronized, Thinking Man Software's freeware program, Dimension 4, Version 4.0, is the solution.

The program synchronizes your computer's clock to your choice of Internet-based chro-

nometers to within 0.05 second. You can download Dimension 4 from <http://www.thinkman.com/~thinkman/> or from the FTP site <ftp://ftp.winsite.com/pub/pc/>



SYNCHRONIZE YOUR WATCHES: Dimension 4, Version 4.0, allows you to set all the timekeeping options in a single panel.

[win95/netutil/4dtime40.zip](http://www.thinkman.com/win95/netutil/4dtime40.zip).

Innovative and custom-configurable, Dimension 4 can be set to run hidden so that it resets your PC's clock each time you connect to the World Wide Web with a dial-up PPP connection. If you

prefer, you can configure it to initiate a dial-up connection, reset the clock, and exit.

If you have a PC that resides on a network with a TCP/IP Internet link, you can configure Dimension 4 to reset the clock periodically—every 24 hours, for example.

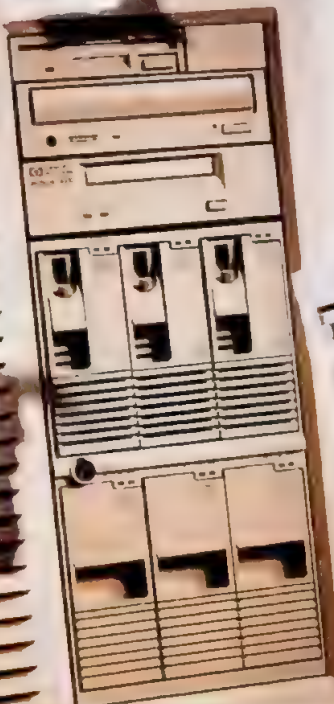
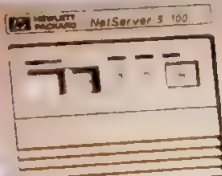
Dimension 4 comes with a large number of SNTP (simple network time protocol) servers for you to connect to, from the Naval Observatory to the Center for Seismology; you can add additional ones.

After you download this innovative piece of Internet-based software, you won't need to ask what time it is.

Dimension 4, Version 4.0. Requires: 4MB RAM, 1MB hard disk space, Microsoft Windows 95 or Windows NT. Thinking Man Software; <http://www.thinkman.com/~thinkman/>. Circle 424 on reader service card.

HP NETSERVERS

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OF THE
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PC
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CHOICE
March 26, 1996
HP NetServer 5100 LSI

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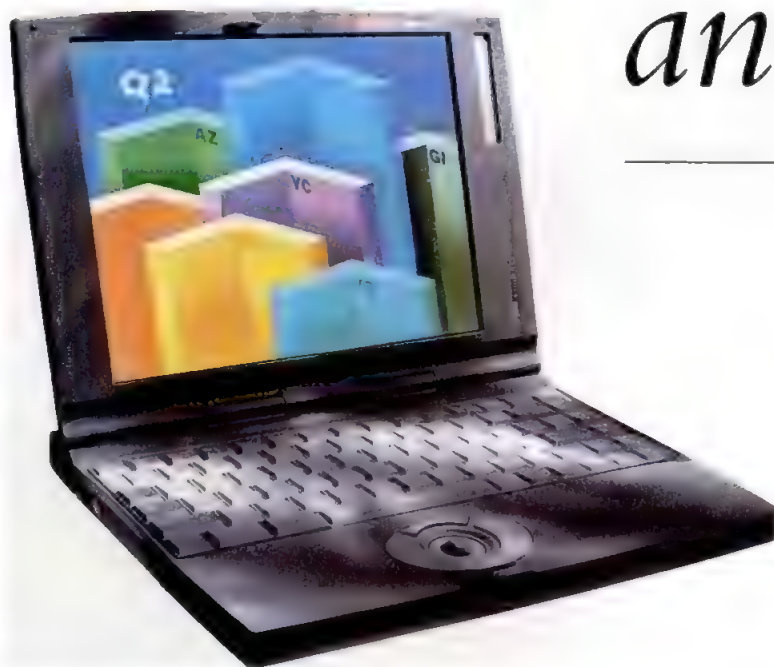
For detailed specs, visit <http://www.hp.com/go/netserver>. Or call 1-800-533-1333, Ext. 1693.

Pictured: HP NetServer 5100 LSI. Awards shown: PC Magazine Editors' Choice HP NetServer 5100 LSI; PC Computing BEST HP NetServer 5100 LSI; LAN Magazine Products of the Year HP NetServer 5100 LSI; Computer Responder News Channel Champion Award NetServer Series. The Intel Inside logo and Pentium are registered trademarks of Intel Corp. © 1996 Hewlett-Packard Company. HP is a registered trademark of Hewlett-Packard Company.

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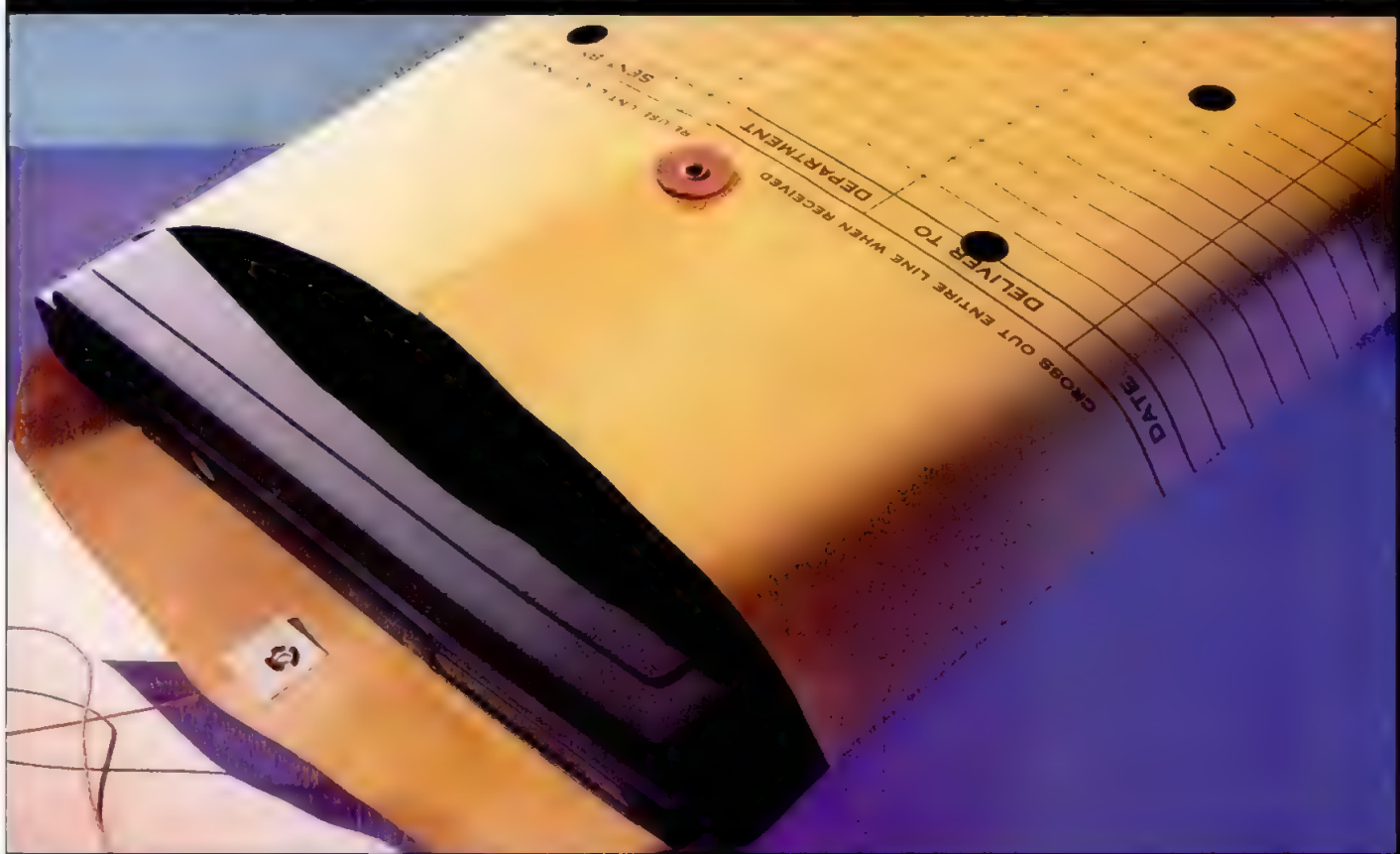
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ACCOUNTING

DacEasy Gets Windows 95 Support and New Features

By Kathy Yakal

DacEasy, the first small-business accounting program for Windows 95, offers transaction processing and reporting power for the functions most commonly used by small businesses: Accounts Payable and Receivable, General Ledger, Inventory, and Payroll. The \$149.95 DacEasy Accounting & Payroll 95 also works in Windows 3.1 and Windows NT.

Although DacEasy 95 represents some of DacEasy's best work, the program lacks conversion utilities for users of earlier versions of the program or other accounting programs. You can expect to see an update this summer.

DacEasy's setup is fast and easy—even though over 100 specialized Charts of Accounts are available—and a section of the online user's guide outlines all the necessary steps. A field-mapping function simplifies data import.

Using tabbed dialog boxes, DacEasy provides repositories for customer, employee, and vendor databases. Other forms, such as purchase orders and invoices, use a similar organizational scheme. You can modify these forms and others, such as reports and checks, in the Layout Designer.

DacEasy's 100-plus reports help consolidate information entered according to its accounting procedures, which comply with the Generally Accepted Accounting Principles. You can customize output design and ranges of data and automatically fax reports or distribute them via e-mail. On-screen previews can't be altered globally, though, so you'll have to adjust the view to see reports clearly.

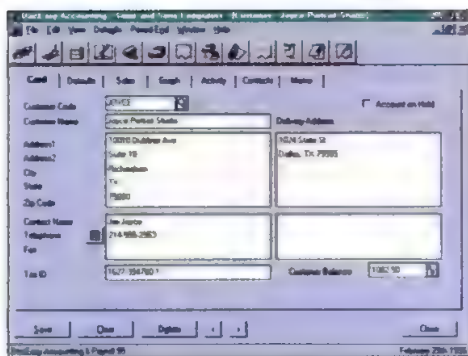
DacEasy weaves limited contact management features into its accounting functions. You can time and document phone calls

follow-up calls scheduled in the phone-call dialog box. And you can print labels and letters for your contacts.

Multiple layers of help explain program operation and accounting processes. Wizards are avail-

able throughout to help with things such as paying invoices and establishing recurring entries. A slim written manual accompanies the program, but the lion's share of help comes from the program's online user guide.

Flash cards that describe several functions and features provide automatic pop-up help, although during evaluation, we found that they didn't pop up consistently. Standard Windows 95 and context-sensitive help augment the other tools.



DIALING FOR DOLLARS: DacEasy has added contact management features to its versatile accounting and payroll package.

(though we were unable to make the dialer work) and automatically move telephone expenses into the invoice module. The Assistant contains the prioritized tasks you've entered as well as

FINANCIAL SOFTWARE

Amortizer96: A Loan Calculator With Professional Power

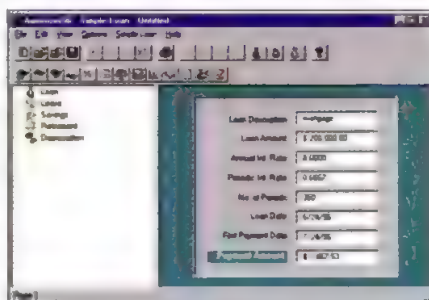
By Don Willmott

Neither a borrower nor a lender be, but in the event that you don't have a choice, Outlook Software Corp.'s \$129 Amortizer96 will help you keep track of every penny.

Much more than a simple loan calculator, the Windows 95-based program handles the math for just about every possible permutation of depreciations, leases, loans, retirement options, and savings plans. Though it's billed as a tool for both the financial expert and the average loan seeker, professionals will make the best use of the program.

Amortizer96 will tackle just about every kind of money lending. You can compare fixed against

floating interest rates, calculate balloon payments, and ponder negative amortization as you plan a loan. It's also fairly easy to work up depreciation schedules using any one of three different models.



LOAN SHARK: Amortizer96 makes it easy to calculate the payments on virtually any type of loan.

The program's reports are useful, especially the simple graphs that illustrate, for example, how interest and principal are paid

Numerous other new features strengthen and add flexibility to DacEasy's latest offering. Inventory now supports *FIFO* (first in, first out), *LIFO* (last in, first out), and Average Costing. Payroll earnings, deductions, and liabilities can be calculated three ways, and a 401(k) retirement plan can be calculated as a percentage. New password parameters let you grant access rights down to the screen level.

DacEasy Accounting & Payroll 95 still lags behind market leaders in terms of functionality and execution, but the power and polish it's taken on in this latest Windows version push it up a notch.

DacEasy Accounting & Payroll 95. List price: \$149.95. Requires: 4MB RAM (8MB recommended), 12MB hard disk space, Microsoft Windows 3.1 or later, Windows 95, or Windows NT. DacEasy Inc., Dallas, TX; 800-322-3279, 214-248-0205; <http://www.daceasy.com>. Circle 428 on reader service card.

back over the course of a long loan. You can print everything from payment-coupon books to loan applications. Financial professionals will appreciate the ability to go onto the Internet and download the latest rates for bank loans, credit cards, and mortgages as reported by Bank Rate Monitor. This is a subscription service (a free 30-day subscription is included). A CD-ROM version will bundle Microsoft's Internet Explorer.

Users unschooled in banking and finance may find it hard to distinguish among such terms as *straight-line depreciation* and *units-of-production depreciation*. Adequate help is usually a few mouse-clicks away, but you may be put off by Amortizer96's arcane lingo. This program goes far beyond "My Little Mortgage."

Amortizer96. List price: \$129. Requires: 8MB RAM, 8MB hard disk space, Microsoft Windows 95. Outlook Software Corp., Dallas, TX; 800-925-5700, 214-774-0708; <http://www.outlooksoftware.com>. Circle 427 on reader service card.

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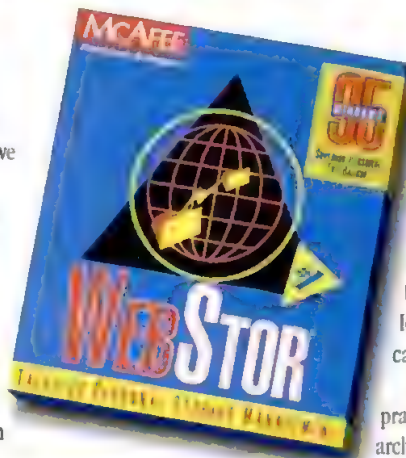
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BUSINESS PLANNING

Plan Your Business like a Pro

By Mary Paulson

Producing a solid business plan can be difficult, especially if you don't know where to start. The \$89.95 Tim Berry's Business Plan Pro, now in Version 2.1, integrates word processing and spreadsheet capabilities with the ability to handle graphics in one standalone program.

Business Plan Pro walks you through the development process step by step with the aid of examples, context-sensitive help, and an accompanying manual. The program works in three modes: text, tables, and charts. Each mode has a corresponding pull-down menu and an Options button in the far right-hand corner.

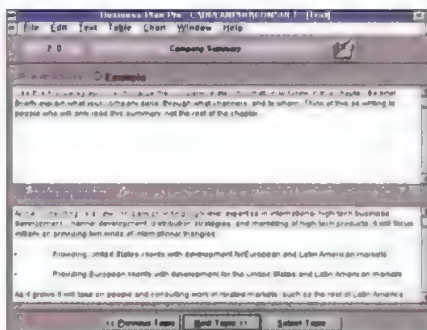
The text mode is not as full-featured as a standalone word processor, but it does include preformatted document templates.

Though this may be a relief if you are a business novice, you can't apply formatting (bold, underline, or italics) to your text on your own. Version 2.1 does, however, let you produce numbered and bulleted lists for a concise, organized look.

Analysis tables are automatically linked to the information that you input in text mode. The tables are set up much the way they would be in a spreadsheet program but again, as in text mode, without all the formatting options of Excel. All financial formulas are preprogrammed, though you can view the formulas by clicking on the cells. If you prefer to work on full spreadsheets, Business Plan Pro allows you to move table files into a compatible spreadsheet package, such as Excel. Corresponding charts are also predefined and au-

tomatically linked to the information included in the tables.

One of the most impressive features of Business Plan Pro is its ability to compile and print your entire document, including tables and charts, in the correct sequence,



JOB INTERVIEW: Business Plan Pro walks you through drafting a business plan.

with page numbers, headers, footers, and proper styles for titles. You can also print tables, charts, or text individually. Other new features include a spell-checker, an option for long-term planning, more printing and formatting prefer-

ences, and context-sensitive help.

The printed documentation is the real gem, serving not only as a program guide but as a tutor for learning basic business-planning concepts, with examples, practical advice, a glossary of terms, and even case studies. The company's World Wide Web site, <http://www.pasware.com>, is also a good resource.

Business Plan Pro is an easy-to-use, full-featured planner for those who want to spend less time developing a plan and more time growing their businesses.

Tim Berry's Business Plan Pro. List price: \$89.95. Requires: 4MB RAM, 5MB hard disk space, Microsoft Windows 3.1 or Windows 95. Palo Alto Software Inc., Eugene, OR; 800-229-7526, 541-683-6162; <http://www.pasware.com>. Circle 401 on reader service card.

UTILITIES

SmartBoard: The Intelligent Windows Clipboard

By Barry Simon

Insight Software Solutions' SmartBoard is a \$24.95 shareware program that acts as a Clipboard extender. It allows you to capture multiple clip items as you paste them to the Clipboard and then retrieve them for later use.

Once you load SmartBoard in your Startup Group under Windows 3.1 or Windows 95, it works behind the scenes. A hotkey or a right-click on the system menu of the application in use activates SmartBoard's Control Panel. From the Control Panel, you can browse previous clips and choose one to edit, print, or paste into an active application. SmartBoard can remember clips from previous sessions, even after you restart Windows.

SmartBoard supports all Clipboard formats. You can configure the utility to limit clip items to a

Other—all accessible via the Control Panel's tabbed dialog box.

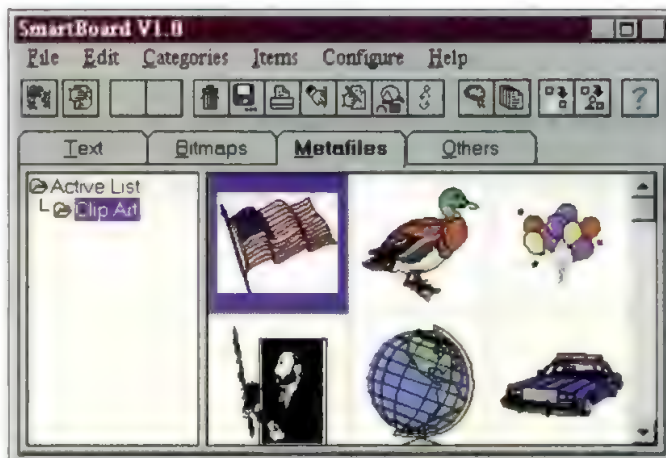
There are many enhancements for handling text. You can search all the clips for a given string or edit a text clip from within the Smart-

SmartBoard includes a .WAV viewer, and the program allows you to add in viewers for special file types. A separate Windows 95 Explorer viewer—available from Insight Software Solutions' World Wide Web site—allows you to right-click on a clip item containing several files and view the contents by filename.

Any clip, text or otherwise, can be given a nickname for quick reference within SmartBoard. Such clips are then saved to disk so SmartBoard can handle numerous large clips without taking up too much memory. Any clip can be assigned a hotkey, which is useful for making a library of boilerplate text available with a single keystroke.

Sure, you can use the Windows Clipboard without SmartBoard, but why would you want to?

SmartBoard, Version 1.0. List price: \$24.95. Requires: 4MB RAM, 1MB hard disk space, Microsoft Windows 3.1 or Windows 95. Insight Software Solutions Inc., Bountiful, UT; 801-295-1890; fax, 801-299-1781; <http://www.smartcode.com/iis>. Circle 402 on reader service card.



CLIPBOARD GALLERY: SmartBoard organizes clip items by type and displays graphics as thumbnails.

particular file size and specify what file formats to use for capturing items from particular applications. As you copy items, SmartBoard files them in one of four folders: Text, Bitmaps, Metafiles, and

Board Control Panel. With a few mouse-clicks you can remove all the carriage returns from a text clip. One useful feature is the ability to configure SmartBoard to append text to the last clip saved.



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HARDWARE

Omnipost Analyzer: The Lazarus Board

By Alfred Poor

The power light's on but nobody's home in your computer. Where do you start to diagnose a dead system?

Omnipost Analyzer, from Omni Diagnostics, is a \$799 single 16-bit ISA card that will work in an 8- or 16-bit ISA slot or an EISA slot and diagnose a variety of problems. Omnipost's LEDs report on IRQ and DMA functions as well as the system's electrical power. A two-digit segmented LED provides alphanumeric clues as to what's going on in your computer during the power-up cycle. This

lets you identify precisely where things go awry, even when the computer's display isn't working.

Analyzer has on-board flash memory that contains Exper-Trace, a self-booting diagnostic program. After the power-on self-test, you can choose to run either the diagnostic utility or test the system normally. The flash memory makes updating the board from a floppy disk easy, and the fact that the program is on-board means that it can run on any system, regardless of the operating system.

In addition to the card and its

on-board software, you also get hardware devices for testing parallel and serial ports and a copy of Eurosoft's PC-Check, an extensive program that covers everything from diagnostics to hard disk utilities to new system burn-in processing.

You could buy a handful of separate diagnostic cards (and spend more money in the process), but they probably won't tell you anything that the Omnipost Analyzer kit can't find out just as easily. In case you ever have to bring a computer back

HOUSE CALL: Omnipost Analyzer's LED helps you diagnose problems even when your PC's display no longer functions.

from the dead, the kit will likely pay for itself on its first use.

Omnipost Analyzer. List price: \$799. Omni Diagnostics Inc., Clearwater, FL; 800-809-6906, 813-546-1966; fax, 813-546-0953. Circle 403 on reader service card.



DOCUMENT MANAGEMENT

PaperMaster 2.0: The Easy Way To Shuffle Paper with Your PC

By J.W. Olsen

More than any of its current competitors, the \$169 PaperMaster 2.0 strictly adheres to the paradigm of a traditional filing cabinet. By maintaining its highly intuitive interface, DocuMagix offers a solution likely to meet all the basic document management needs of SOHO users.

Like Caere Corp.'s PageKeeper, PaperMaster focuses on the organizing needs of individual users rather than workgroups. Although you can run PaperMaster on a network, data integrity is provided on a file rather than a record-locking level. Unfortunately, this means that if another user is accessing a PaperMaster virtual cabinet, you must wait.

PaperMaster makes it easy to annotate, input, organize, and output your documents into cabinets, drawers, and folders that you can easily customize to suit your needs.

Data can be entered by scanning (with built-in OCR functionality), by directly moving graphics files in five popular formats into a cabinet, or by using MAPI-

and VIM-compliant e-mail and fax systems. PaperMaster installs a reliable Windows printer driver, so anything you can print from a Windows application can be filed. Output options include duplicating cabinets on diverse removable media, fax, and e-mail.

You can annotate PaperMaster documents in two ways: Sticky notes appear as icons on documents, or you can anno-

installs itself on Windows 95 systems, it puts a PaperMaster inbox on your desktop and adds a Send To option on file-context menus in Explorer. Another option lets you create new PaperMaster documents by right-clicking on the Windows 95 desktop.

DocuMagix acknowledges two rough edges: Exported documents overwrite existing files that have the same names without warning. And if you use Auto-Crop/Straighten Pages, you must do so before saving your document. You can't use this function or undo its effects once you have

PaperMaster SE. In conjunction with a printer and a fax modem, the scanner added impressive copying and faxing capabilities as well as tight hardware-software integration.

Along with scanned material, you can now store information from the Internet in PaperMaster cabinets with DocuMagix's \$79 HotPage. HotPage allows you to capture Web pages within your browser as TIFF images or HTML documents ("Making Sense of the Web," First Looks, May 28, 1996).

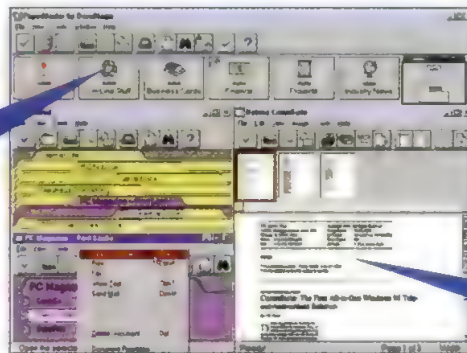
With all-around flexibility (including versatile import and export options), tight integration with Windows 95, and exceptional ease of use, PaperMaster may be the best document management solution for SOHO users.

PaperMaster 2.0. List price: \$169. Requires: 8MB RAM, 7MB hard

PERSONAL FILES: You can create custom file drawers and folders with different colors, icons, and names.

tate directly onto document overlays, which is a handy feature for completing online forms. Annotations travel with documents when you send them by e-mail or fax. PaperMaster has added support for gray-scale and color documents.

When the 16-bit PaperMaster



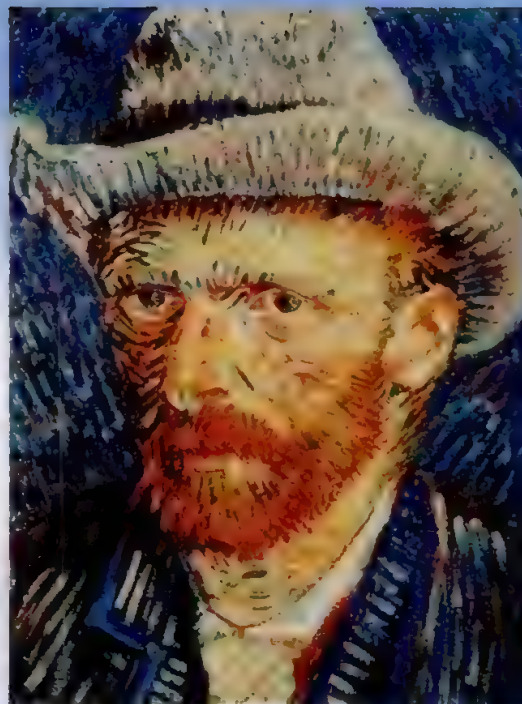
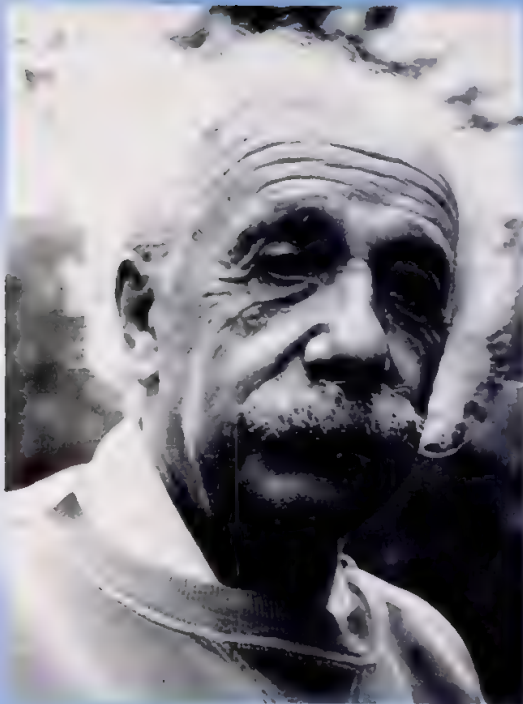
THE PAPER CHASE: Modeled after the traditional file cabinet, PaperMaster—together with your scanner—helps bring order to cluttered desks and hard disks.

filed your document.

We also looked at the \$399 Logitech PageScan Color scanner, which included a copy of

PAPERLESS: You can view stored documents as thumbnails or full pages, which can contain personal notes.

disk space, Microsoft Windows 3.x (with 8MB permanent swap file) or Windows 95; Twain- or ISIS-compliant scanner and fax modem optional. DocuMagix Inc., San Jose, CA; 800-362-8624, 408-434-1138; <http://www.documagix.com>. Circle 404 on reader service card.



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In search of the perfect PC? Just ask *Business Week*. In its First Annual Computer Buying Guide, the Dell Dimension XPS P133c was rated #1 among the "Best Bets for PC Buyers."

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WEB PROGRAMMING

Java: It's Not Just for Breakfast Anymore

By Jay Munro

One of the most hyped developments of the Internet, the Java programming language, is also one of the most widely misunderstood.

Java is a powerful, object-oriented language for building platform-independent and multimedia applications, as well as more mundane nongraphics programs. Most Web surfers are fa-

miliar with Java's glitzy applets for scrolling text, creating animated bitmaps, and prompting users for

Visit <http://www.pcmag.com/discuss.htm>, June 17 to 21, to discuss Java with the authors.

input, but Java can also be used to develop standalone forms and database applications.

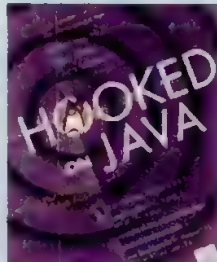
The five books we reviewed range from introductory guides for nonprogrammers to comprehensive programming courses, and each contains sample code.

www.pcmag.com

From Instant Applets to Brew-Your-Own Java Apps



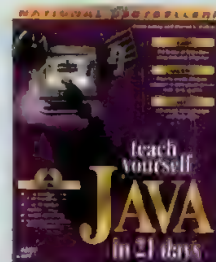
• *Instant Java*, by John A. Pew, delivers quick Java applets for dressing up your Web pages. Geared toward non-programmers, *Instant Java* (\$29.95) provides over 60 prebuilt applets on a CD-ROM, along with the beta 1.0 version of Sun's JDK and a lite version of Symantec's Café 1.0 (First Looks, June 11, 1996). The CD also contains sample code from SunSoft Press's other books, *Core Java*, *Java By Example*, and *Just Java*. *Instant Java* starts with an overview of Java and how to add applets to HTML code and then describes the basic functions of applets. Each function is illustrated with generic applets and supplemented with information on the required HTML code, common settings, and relevant examples. SunSoft Press, <http://www.sun.com/smi/ssoftpress>; ISBN: 0135658217.



• Written by Arthur van Hoff and Sami Shaio, members of the Java development team, and Orca Starbuck, a support engineer, *Hooked On Java: Creating Hot Web Sites with Java Applets* (\$29.95) is a collection of Java applets for adding pizzazz to Web sites. A chapter on applet basics explains how to add Java applets to your page and how to copy them to your site. The CD-ROM includes applets for animation, audio, graphics, mouse, keyboard, and text usage. The authors describe and illustrate each applet and provide a sample piece of HTML code. The rest of the book is a guide to writing Java applets. Most topics include short sample programs that are especially helpful when you get into inheritance, threads, and interfaces. Addison-Wesley Publishing Co., <http://www.aw.com>; ISBN: 020148837X.



• Michael C. Daconta's *Java for C/C++ Programmers* (\$39.95) is designed for programmers who already understand the ins and outs of Java. The book's two sections include a comparison of Java to C/C++ and a guide to programming in Java and JavaScript with working code samples. Java, like C/C++, is based on a set of prepackaged libraries, and nearly one-quarter of the book is devoted to describing the Java Standard Library. This section alone will make the book invaluable to C/C++ programmers. The majority of the book's explanations and code are based on standalone programs; applets, the HotJava browser, and JavaScript are only briefly discussed. *Java for C/C++ Programmers* is a must-have for programmers trying to make the transition to Java. Wiley & Sons, <http://www.wiley.com>; ISBN: 0471153249.



• If you get only one Java book, it should be *Teach Yourself Java in 21 Days* (\$39.99). Authors Laura Lemay and Charles L. Perkins cover all aspects of Java programming in an easy-to-read guide organized around daily lesson plans. The book opens with an introduction to Java and a good explanation of object-oriented programming. In the first week, you learn about Java variables, classes, methods, and application-building. During the second week, the authors introduce applets and the Java Class Libraries. In the final week, the book delves into abstract and final methods, threads and exceptions, and creating your own packages. *Teach Yourself Java in 21 Days* also includes lessons on using native code that links C code to Java programs. Sams.net Publishing, <http://www.mcp.com/samsnet>; ISBN: 1575210304.



• At more than 800 pages, *Java Programming EXplorer* (\$39.99), by Neil Bartlett, Alex Leslie, and Steve Simkin, is the heaviest book of this group. It's also one of the most comprehensive guides to developing Java applets, but its breezy tone can be distracting. Underneath its unorthodox design and offbeat titles ("Nice Threads Javaman"), the book provides some good ideas. Code examples show how to build a Grep utility, a schematic (electronic components) class, and a guitar-chord control. The Do-It-Yourself-Internet section describes how to use Java's socket and URL classes, with a quick Whols program. Some will be turned off by its style while others will find it essential, but all will agree that *Java Programming EXplorer* covers lots of ground. Coriolis Group, <http://www.coriolis.com>; ISBN: 1883577810.

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Second Looks

LIVING WITH THE PRODUCTS WE REVIEW

By Brian Nadel

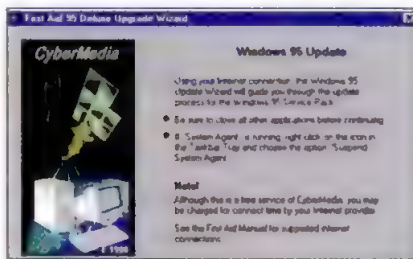
WINDOWS 95 UTILITIES

First Aid 95: Potent PC Therapy

WHEN WE FIRST REVIEWED CyberMedia's First Aid 95, we were impressed with the program's ability to ferret out minor Windows file problems (First Looks, January 23, 1996). Unfortunately, the program was prone to general protection faults (GPFs) and could do a lot of damage in the wrong hands.

CyberMedia went back to the drawing board and revamped First Aid 95 with stronger repair modules. On the whole, Version 2.1 is much more stable, and the program's AutoFix function can repair a greater variety of broken or stuck windows

than before. The update files are available from a variety of online services and CyberMedia's World



Wide Web site (<http://www.cybermedia.com>), but follow the detailed installation instructions.

As effective as Version 2.1 is, the recently released \$60 First Aid 95 Deluxe is even stronger medicine. The program breaks new ground by using the Internet to perform automatic updates to

Windows 95. Called CyberFix, this feature may seem like a miracle cure to anyone who's spent hours baby-sitting a large download only to find that either the wrong file has been grabbed or part of it got scrambled over the phone lines.

Start by selecting Windows 95 Update from the Explorer, but make sure that you've suspended the System Agent in the Taskbar Tray before you proceed. First Aid 95 Deluxe connects with CyberMedia's FTP server, which then routes the needed update files from Microsoft's server directly to your system. First Aid 95 Deluxe puts the updates in the correct places and saves the originals.

On our tests, CyberFix automatically installed Microsoft's Windows 95 Service Pack 1 (Second Looks, May 14, 1996) onto our PC in record time while we discussed more pressing business at the watercooler.

ANTIVIRUS PROGRAMS

Dr. Solomon's Postdoctoral Course in Virus Scanning

ALTHOUGH WE LIKED THE ability of Dr. Solomon's Anti-Virus Toolkit to find and fix a variety of viruses in innovative ways, two serious shortcomings continued to give us pause ("Antivirus Utilities," May 14, 1996): the lack of support for the insidious macro virus, which can infect seemingly safe document files, and the program's lack of certification from the National Computer Security

Association (NCSA).

Both of these deficiencies have been addressed in Dr. Solomon's latest upgrade. Registered users will automatically receive these essential updates, which are part of S&S Software International's quarterly upgrade subscription service.

On tests, Dr. Solomon correctly diagnosed and repaired a macro virus hidden in a Word for Windows file.



NOTEBOOKS

Seeing Red Over Infrared



ALTHOUGH MANY OF THE notebooks that shipped shortly after Windows 95's release provided all the necessary IrDA hardware, as it turns out that was nothing more than a Potemkin village. That's because the infrared drivers from Microsoft that support wireless printing and file transfer were not ready yet. Some of the larger vendors wrote their own drivers, but the smaller vendors tended to look the other way.

Now there's an easy remedy. The process shouldn't take more than 10 minutes. First, download and install the W95IR.EXE drivers from Microsoft's World Wide Web site (<http://www.microsoft.com>) or CompuServe. Second, set the drivers to the recommendations in the user's manual (COM 3 and LPT 3 generally work well). Third, test the drivers by printing or transferring files to an IrDA device. Finally, toss out those old parallel cables.

BUG BRIEFS

PROBLEM

Brother HL-600 printers have trouble printing white-on-black text.

SOLUTION

In *Printer Setup* under Windows 3.1, set the TrueType option to "Print as Graphics" and save the page as a graphic and then print it.

PROBLEM

Agfa's scanner software, FotoLook, has trouble running under Windows 95.

SOLUTION

Version 2.08 of FotoLook is fully compatible with Windows 95 and adds ASPI plug-in support and built-in color correction. Call Agfa at 508-658-5600.

LOOKING AHEAD

Tell us what you love and hate about these products and we'll share the information in future issues.

• ClarisWorks 4.0 • Color ink jet printers • CD-ROM

encyclopedias • EZ-SCSI 4.0 • Lotus Notes Release 4 • Microsoft Internet Explorer • Netscape Navigator 2.0 • Pentium Pro PCs • RealAudio • SoftWindows

• Windows 95 utilities. Contact Brian Nadel directly via MCI Mail (556-1500) or CompuServe (72241,1616), or on the Internet at bnadel@zd.com.

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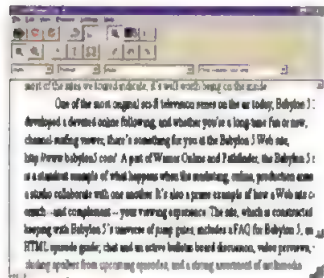
New & Improved

NEWS OF ANNOUNCED PRODUCTS AND UPGRADES

By Melissa J. Perenson

Recognition with Character

BRIDGING THE WIDE GAP between image files and editable text files is the job of **TextBridge Pro 96 for Windows 95**, a \$260 optical character recognition (OCR) package from Xerox Desktop



OCR FOR PROS: Xerox's **TextBridge Pro 96 for Windows 95**.

Document Systems. TextBridge has improved the accuracy of its impressive OCR engine and adds a more intuitive interface, the ability to retain a page's layout through the OCR process, and seamless integration with popular word processing applications. Another key feature is SoftQuad's HTML editor, HoT-MetaL light 2.0, to facilitate the

scanning, OCR, and editing of paper-based information that will be posted on the World Wide Web.

Caere Corp., the other big player in OCR software, is also in the game with its **\$500 OmniPage Pro for Windows 95 Version 7.0**. Like TextBridge Pro, OmniPage is also pushing the envelope, improving its OCR, HTML formatting, page-layout retention, and output accuracy while adding such convenient features as an OCR wizard and OLE 2.0 support.

Xerox Desktop Document Systems, Peabody, MA; 800-248-6550, 508-977-2000; <http://www.xerox.com>. **Circle 408 on reader service card.**
Caere Corp., Los Gatos, CA; 800-535-7226, ext. 110; 408-395-7000; fax, 408-354-2743. **Circle 409 on reader service card.**

Graphical Punch

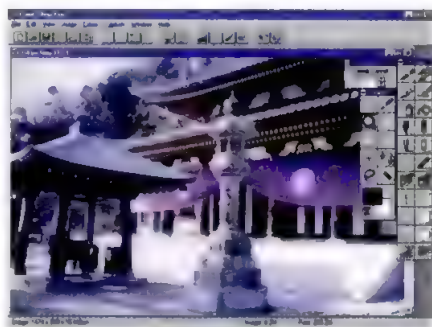
WHETHER YOU WANT TO ADD OOMPH TO YOUR IMAGES or you just want to capture an image, JASC Software has a product for you.

The **\$99 Paint Shop Pro Power Pack** offers a formidable one-two punch, as it includes both the 16-bit and 32-bit versions of Paint Shop Pro and the 16-bit Version 2.0 and the 32-bit Version 3.0 of Kai's Power Tools SE, an image-effects package from MetaTools.

Paint Shop Pro is a full-featured image editor that supports image enhancement, batch conversion, screen capture, and the Twain standard.

If you find yourself tired of Windows 95's PrintScreen button, then the flexible, \$39 **JASCapture** is just what you need. This 32-bit version of JASC's popular screen-capture software lets you grab only the portion of the screen that you need.

JASC Inc., Minnetonka, MN; 800-622-2793, 612-930-9800; <http://www.jasc.com>. **Circle 411 on reader service card.**



HOT PROSPECT

A Notebook Ahead of Its Time

Finally, there's a notebook computer that gets it just right. IBM PC Co., which has long borne the mantle of innovator when it comes to notebooks, strikes a chord with its ThinkPad 560 series of notebooks.

Unlike your average lightweight notebook, such as the Toshiba Portégé (shown below on top of the ThinkPad), the **IBM ThinkPad 560** has a slim line and a wide surface that makes handling the unit a breeze; the unusual dimensions are 11.7 by 8.7 by 1.2 inches, which also allow for a full-size keyboard and a wrist rest. Weighing in at just 4.1 pounds, the units in the 560 series are available with 100-, 120-, and 133-MHz Pentium CPUs, either 810MB or 1.0GB hard disks; and large 11.3-inch passive-matrix and roomy 12.1-inch active-matrix displays, which produce crisp, robust images. All units come with 8MB of RAM, a Type III PC Card slot, an IrDA port, a lithium ion battery, and Sound Blaster-compatible sound; the floppy disk drive attaches externally. Notebooks in the 560 series start at just \$2,699, with the more powerful configurations costing about \$4,000.

IBM PC Co., Armonk, NY; 800-772-2227; <http://www.pc.ibm.com/thinkpad>. **Circle 423 on reader service card.**



Disk Expander

ARE YOU RUNNING OUT OF hard disk space? Adaptec's \$599 **Power Storage Hard Drive Kit** may be the perfect external solution

for you. This easy-to-install all-in-one kit, which is available for both ISA and PCI buses, includes a neatly self-contained, external 1GB SCSI hard disk and an Adaptec SCSI host adapter.

Adaptec Inc., Milpitas, CA; 800-959-7274, 408-945-8600; <http://www.adaptec.com>. **Circle 410 on reader service card.**



Pop-Up Jack

FRUSTRATED WITH THAT ANNOYING dongle dangling precariously off the side of your PC Card modem? Simple Technology has come up with a simple solution to this common problem. Simple's \$299 **28.8 Communicator**, a 28.8-Kbps PC Card data/fax modem, now allows you to connect a standard RJ-11 phone cord directly into the innovative, pop-up SimpleJack connector. The unique SimpleJack keeps the phone card horizontally positioned, thus avoiding the problems that can arise with a vertical connection.

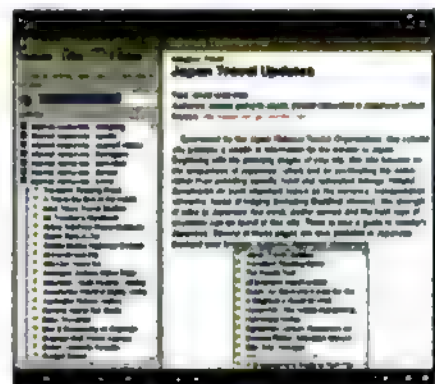
Simple Technology Inc., Santa Ana, CA; 800-367-7330, 714-476-1180; <http://www.simpletech.com>. **Circle 412 on reader service card.**



Enhancing a Virtual Bookshelf

ONE OF THE HANDIEST REFERENCE CD-ROMs AROUND HAS just become handier. Microsoft Corp.'s \$50 **Microsoft Bookshelf 1996-97 Edition** features impressive content and interface enhancements.

Of the nine references collected on this disk, seven have been updated and two have been added. Returning references include The American Heritage Dictionary, The Columbia Dictionary of Quotations, and The Original Roget's Thesaurus of English Words and Phrases.



The most significant addition is that of Internet Directory 96. Working in concert with any Web browser, this directory provides descriptions of and links to about 5,000 Internet resources, including those available via the Web, Gopher, FTP, and Usenet. The other new source is The Concise Encarta 96 World Atlas, which is derived from the Encarta 96 World Atlas and combines detailed maps with country data.

Microsoft Corp., Redmond, WA; 800-426-9400, 206-882-8080; <http://www.microsoft.com>. *Circle 413 on reader service card.*

Convertible Printers

THAT'S RIGHT—WE'RE talking about printers, not cars. The term was coined by Canon Computer Systems as a way to describe its latest multi-function printers, including the \$600 **MultiPass C2500**.

A scanner, fax machine, copier, and printer all rolled into one, the C2500 distinguishes itself from the competition by offering color printing using Canon's 720- by 360-dot-per-inch (dpi) Bubble Jet



technology. The device has a print engine that's rated at 5 pages per minute for black text and features a fax-transmission speed of 6 seconds per page, a fax memory of around 40 pages, a 99-page capacity, and a 360-dpi copier. The downside to the C2500 is that it only scans at 200 dpi, which is not enough for using scanned documents with OCR.

Canon Computer Systems Inc., Costa Mesa, CA; 800-848-4123, 714-438-3000; <http://www.ccsi.canon.com>. *Circle 414 on reader service card.*

Translations

IF YOUR BUSINESS INVOLVES dealing with Japan, then Neocor Technologies' 32-bit machine-translation products will prove useful. The \$890 **Typhoon MT 5.0** provides Japanese-to-English translations, while the \$690 **Tsunami MT 5.0** translates documents from English to Japanese. Each features better dictionaries

and improved translation engines over previous versions. OLE 2.0 support, coupled with support for both the ASCII and Shift-JIS formats, lets you simply drag and drop English or Japanese text from other programs—including your Web browser—into either Typhoon or Tsunami for translation.

Neocor Technologies, La Jolla, CA; 800-693-9283, 619-483-2524; <http://www.neocor.com>. *Circle 415 on reader service card.*

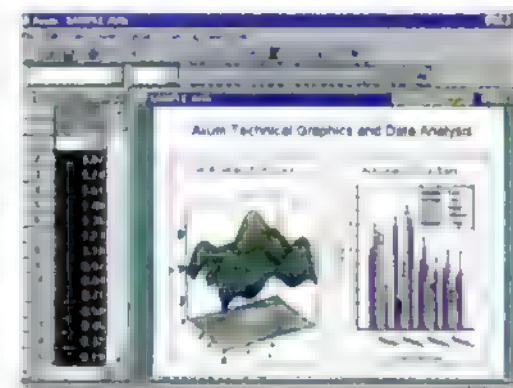
Management Essentials

DO YOU HAVE EMPLOYEES WHO COULD STAND A BIT OF training? Harvard Business School Publishing's **Interactive Manager** series of CD-ROMs provides a flexible and cost-effective way to train managers at all levels. The \$450 High Performance Management features tools for assessing your skills, case studies, role-playing, and a database of relevant *Harvard Business Review* articles. The \$450 Managing Across Difference covers issues involving diversity in the workplace.

Harvard Business School Publishing New Media Group, Boston, MA; 617-495-6700; fax, 617-496-8066. *Circle 416 on reader service card.*

Analytical Axum

A POWERFUL, PROFESSIONAL technical-graphics and data-analysis tool, MathSoft's \$300 **Axum 4.1** provides a new level of functionality. The program, which is now seamlessly integrated with Mathsoft's Mathcad 6.0, lets you create "live" Axum graphs from within Mathcad using your Mathcad data. You can also create customized 2-D and 3-D graphs by dragging and dropping data from any OLE 2.0 application. **MathSoft Inc.**, Cambridge, MA; 800-628-4223, 617-577-1017; <http://www.mathsoft.com>. *Circle 417 on reader service card.*



BRIEFS

Books

Expanding on its popular **for Dummies** series, IDG Books has created a new series of books designed for educators. **The Internet for Teachers** and **The World Wide Web for Teachers**, both written by Dr. Bard Williams, introduce educators to the online world and its uses in the classroom (\$19.99/\$24.99, IDG Books Worldwide, 800-434-3422) Let your computer do the talking with **Computer Telephony: Automating Home Offices and Small Businesses**, a practical guide to setting up telephony systems for SOHO users, by Ed Tit-

tle and Dawn Rader (\$24.95, Academic Press, 800-313-1277) Does your computer have a mind of its own? Author William D. May explores the theoretical limits of computer intelligence in **Edges of Reality: Mind vs. Computer** (\$28.95, Insight Books, 212-620-8460).

Internet

Stanford Testing Systems' \$995 **IBTauthor** revolutionizes how the Internet can be used as a training tool. This Internet-based training authoring system lets you create fully interac-

tive training courses for deployment on the World Wide Web (509-468-5100) Reach out and talk with someone with NetPhonic Communications' **Web-On-Call Voice Browser**. Priced at \$1,000 per telephone line installed on the Web server, this package uses text-to-speech technology so you can access Web documents over your telephone or fax machine (415-962-1111).

Hardware

Targeting the consumer market, UMAX Technologies' \$399 **Vista-S6e** scanner offers

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4 more cells than most notebooks plus 52 watts mean longer on-the-road computing with enough battery life to run your CD-ROM.

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Pick your pointing device: a standard dual-button pointing stick or optional touchpad (pictured)

11.3" SUPER VGA Active Matrix Display
Extra large display with bright, vivid 800 x 600 color gives you a bigger picture

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32-bit PCI Local Bus PCMCIA controller to accommodate both type II and type III for a greater variety of options

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WinBook FX

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- 4X CD-ROM MODULE
- 6.8 POUNDS (WITH FDD)
- 12-CELL 52 WATT LITHIUM ION BATTERY
- 32-BIT LOCAL-BUS VIDEO
- 16-BIT SOUNDBLASTER COMPATIBLE STEREO SOUND
- 1MB VIDEO RAM
- 256K SYNCBURST CACHE
- ONE TYPE II AND ONE TYPE III PCMCIA SLOT
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- Flash BIOS for easy upgrade
- Designed for Windows® 95
- Preloaded HP DMI Desktop Management Interface
- Free three-year limited warranty for parts and labor¹

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HP Vectra VE

Best managed PC.

- Intel 75, 100, 120, 133, 150 or 166 MHz Pentium processor
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- Network certified and preconfigured for Microsoft® and Novell clients
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- Vectra Op-Center
- Norton Smart Disk Doctor
- Parallel transfer driver preinstalled for faster LAN packet processing
- Advanced security meeting C2 level
- 64-bit graphics accelerator on PCI bus
- 1MB video RAM, expandable to 2MB
- 8 or 16MB EDO RAM, expandable to 128MB
- 840 or 1280MB Enhanced-IDE hard drive
- 4 mass storage shelves (3 front accessible), 4 expansion slots
- Two 32-bit PCI slots
- Flash BIOS for easy upgrade
- Designed for Windows 95
- Free three-year limited warranty for parts and labor¹

from **\$1,449***



HP Vectra XM

Leading Pentium processor/PCI performance at an affordable price.

- Intel 100, 120, 133, 150 or 166 MHz Pentium processor
- Desktop and minitower packages
- 256KB burst synchronous cache
- 8-16MB RAM, expandable to 128MB
- EDO RAM
- PCI/ISA architecture
- 640MB** high-performance Enhanced-IDE hard drive
- PCI integrated graphics accelerator and 1MB DRAM standard, upgradable to 2MB or Matrox Millennium PCI graphics card with 3D acceleration and 2MB WRAM, upgradable to 8MB
- Flash BIOS for easy upgrade
- Full plug-and-play capability
- Designed for Windows 95
- Preloaded HP DMI Desktop Management Interface
- Free three-year limited warranty for parts and labor¹

from **\$1,579***



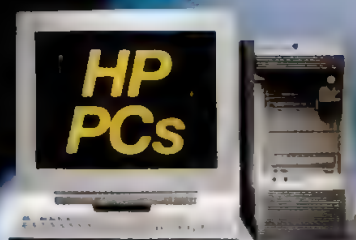
HP Vectra VL

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The ultimate PC.

- Intel Pentium Pro 150, 180 or 200 MHz processor with 256KB integrated cache
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- 128-bit high-performance memory architecture
- 16-32MB ECC DIMM memory standard, expandable to 256MB with 8 DIMM memory expansion slots
- PCI integrated Ultra SCSI Fast 20 interface with 20MB/s throughput
- 1,000MB** SCSI-2 high-performance hard drive
- PCI Matrox Millennium graphics card with 3D acceleration and 2MB WRAM, upgradable to 4MB or 8MB
- 7 mass storage shelves (5 front accessible)
- 6 expansion slots: 3 PCI, 1 PCI/ISA combo and 2 ISA
- 10Base-T/100VG AnyLAN selectable PCI NIC with up to 100 Mb/s throughput
- Integrated 16-bit audio and 4X CD-ROM
- Microsoft Windows NT® 3.51
- Free three-year limited warranty for parts and labor¹

from **\$3,939***



HP Vectra XU

- Intel Pentium Pro 150 MHz processor with 256KB integrated cache
- 128-bit high-performance memory architecture
- 16MB DIMM memory standard, expandable to 256MB with 8 DIMM memory expansion sockets
- 1,000MB** Enhanced-IDE hard drive
- PCI Matrox Millennium graphics card with 3D acceleration and 2MB WRAM, upgradable to 4MB or 8MB
- 7 mass storage shelves (5 front accessible)
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- Integrated 16-bit audio and 4X CD-ROM
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from **\$3,419***



HP Vectra VT

Helpful hint:

Rip out and pin up next to
Compaq and IBM ads.

A little comparison shopping will quickly show you that HP puts the best prices on the most impressive PCs. One standout is the network-ready Vectra XM. It's configured for the most demanding networks with LAN Remote Power, Super-fast LAN install and HP Vectra Op-Center for more effective remote management. Every Vectra will outshine the competition when it comes to features and price. From the Pentium processor-based PCs to the dual Pentium Pro processor-based HP Vectra XU PC. For more information or the name of your nearest HP reseller, call 1-800-322-HPPC, Ext. 1703. Or visit us at <http://www.hp.com/go/vectra>.

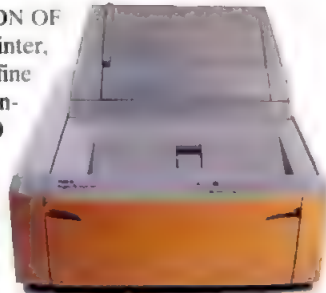


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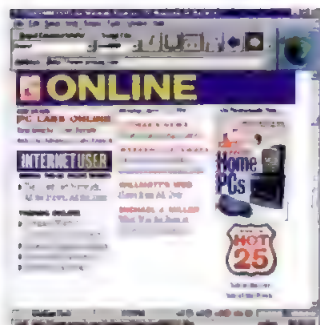
WITH A STRONG COMBINATION OF features and power, NEC's laser printer, the **SuperScript 860**, is poised to redefine the high end for small-office, non-PostScript laser printers. The \$500 SuperScript 860 offers 60- by 600-dpi resolution, a print engine that's rated at 8 pages per minute, and 1MB of RAM. The printer features HP PCL4 emulation and Adobe's printer language, PrintGear, which combines elements of GDI, PCL, and PostScript for improved printing performance. Advanced printing options provided by the enhanced drivers include booklet printing, poster formatting, proof sheets, and watermarks.

NEC Technologies Inc., Mountain View, CA; 800-632-4636, 415-528-6000; <http://www.nec.com>. *Circle 418 on reader service card.*



Not Just a Comm Package

A LONGTIME STAPLE IN THE communications-software arena, Datastorm's \$135 **Procomm Plus**



enters the Internet age with Procomm Plus 3.0 for Windows.

Aside from the addition of OCR to the FaxViewer, the biggest enhancement to Procomm Plus is the inclusion of a complete set of Internet tools, including e-mail, a Usenet newsreader that automates the decoding of binary files, FTP, telnet, Gopher, a Winsock-compliant TCP/IP stack that coexists concurrently with other stacks, and a Web browser. Based on Spyglass Mosaic, the browser has a handy "save page with graphics" option. **Datastorm**, Columbia, MO; 800-474-1568, 573-443-3282; <http://www.datastorm.com>. *Circle 419 on reader service card.*

The Searchers

WHETHER YOU'RE SEARCHING a document or searching on the Web, conducting searches has become a natural extension of your computing routine. That's why CommTech's **PowerSearch**—a pair of utilities for Microsoft Word for Windows and Netscape Navigator—is so helpful. Priced at \$135, PowerSearch lets you conduct Boolean keyword and phrase

searches on up to 8,000 words, and there's also a replace string. PowerSearch lets you organize information you've downloaded or saved and create a hypertext-linked index of the files you create with that information. You can also search across multiple Web search engines; the information is returned in a single report.

CommTech Software, New Haven, CT; 203-495-1960; <http://www.commttechsoftware.com>. *Circle 420 on reader service card.*

You've Got the Power

YOU DIDN'T PLAN ON IT, BUT WHEN YOU FINALLY TOOK the plunge, you ended up spending several thousand dollars on a PC and peripherals. Now, what about protecting your investment from power surges? Uninterruptible power supplies (UPSs) used to be expensive and ungainly ventures for consumers, but new UPSs from SL Waber and American Power Conversion have changed that paradigm.

SL Waber's **UPStart Uninterruptible Power Center** is a sleek unit designed to sit under your monitor. The \$199 device offers up to 5 minutes of backup power, five front-panel control switches and a master switch, and dual 250-volt-ampere backup-power outputs.



POWER SOURCE: The slim UPStart.

On the surface, American Power Conversion's \$179 **Back-UPS Office** doesn't look any different than a standard surge protector. But this device offers far more than simple surge suppression. There are six outlets, three of which have from 7 to 13 minutes of battery backup power.

SL Waber, Mount Laurel, NJ; 800-634-1485, 609-866-8888; fax, 609-866-1945. *Circle 421 on reader service card.*

American Power Conversion, West Kingston, RI; 800-877-4080, 401-789-0204; fax, 401-789-3710. *Circle 422 on reader service card.*

BRIEFS

single-pass, 24-bit scanning at a 300- by 600-dot-per-inch (dpi) resolution (510-651-4000) Meanwhile, Microtek's \$599 **ScanMaker E6** offers single-pass, 30-bit scanning at 600 by 1,200 dpi (310-297-5000) As an alternative to outsourcing your company's large graphics jobs, consider Mannesmann Tally's \$1,699 **T7070**, a full-color, large-format ink jet printer. Maximum output size is 17 by 23 inches, which is appropriate for both posters and signage (206-251-5500) Each of Hewlett-Packard Co.'s multifunction printers, from the **HP OfficeJet Series 300**, pulls multi-

ple duty as a printer, fax, copier, and scanner. Starting at \$549, these printers are rated at 3 pages per minute and produce a 600- by 300-dpi resolution (800-752-0900).

Software

Create your own business cards with MySoftware Company's \$49.95 **MyProfessional-BusinessCards for Windows 95**. This is the best business-card package around; you'll be crafting your own professional-quality business cards in no time (415-473-3600) Lexington Technology's \$995 **ID Maker 1.0** has

everything you need to create a professional-looking I.D. card, including the ability to add bar codes, encode a magnetic stripe, and update picture or signature fields through a video camera or scanner (213-936-9810) Arena International Corp.'s \$388 **HappyAccounts Bilingual Accounting System**, sold separately in Chinese and English, features bilingual accounting modules (604-467-0166) Krolman's \$99 **PictureThis** lets you easily insert photos into your presentations. PictureThis supports most popular presentation packages (800-388-3639).



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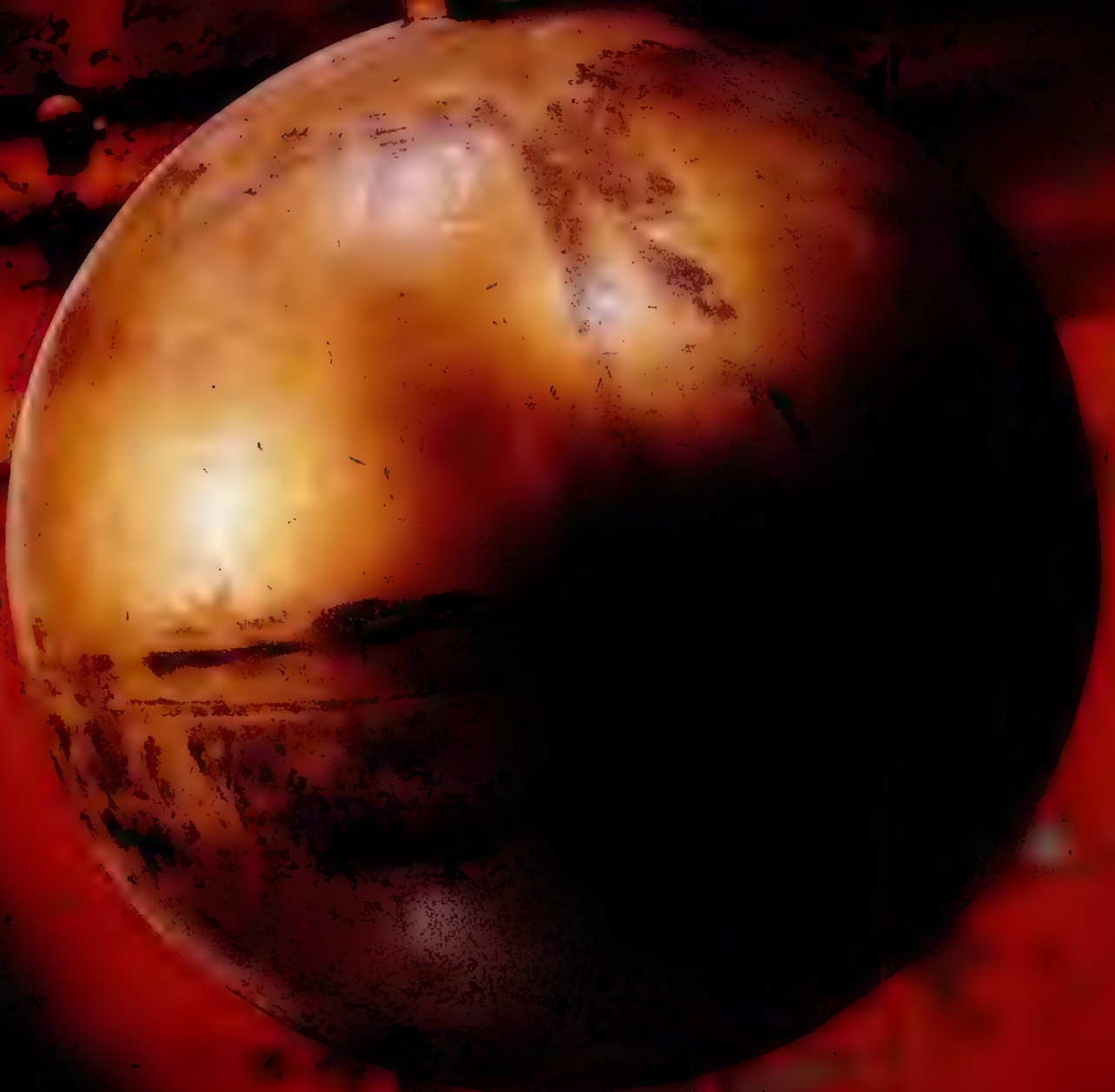
HP OmniBook 5000

*Average U.S. street prices. J.D. Power and Associates, 1995 Notebook Computer Business Satisfaction Study. Office Based Business. Study conducted among 1,331 business users. © 1995 Hewlett-Packard Company. PPG428



Microsoft

WHERE DO YOU WANT TO GO TODAY?



Will the Internet bring an end to business computing as we know it?

Not at all. It will simply knock down the walls between people, between departments — even between companies. The promise of the Internet, while intoxicating to some, is threatening to others. Because along with the unlimited access and opportunity it provides, comes the need for new strategies and new technologies. Happily, those who've begun the transition to client-server already have much of what they need in place. And to help businesses incorporate the Internet and intranet into their operations, Microsoft is integrating the necessary technology into many of its products — from desktop to server to tools.

For example, it's never been easier to connect desktops to the Internet. That's because both Microsoft® Windows® 95 and Windows NT® Workstation operating systems have all the "plumbing" built right in. Viewing content is just as effortless. With Microsoft Internet Explorer, users can browse the Internet (or internal corporate webs) whether they're working on the Windows platform or on the Macintosh.™

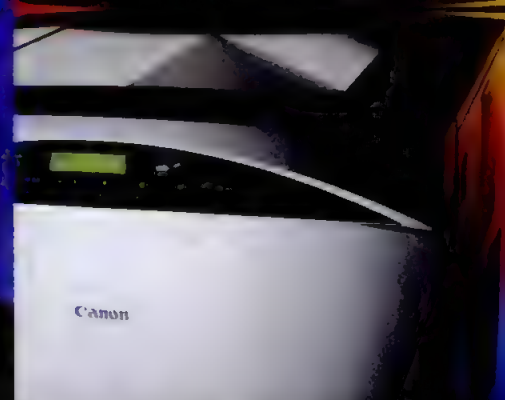
Of course, making web content easy to view is only the beginning. To be useful to organizations, content has to be easy to create, too. Which is why the latest generation of Microsoft Office applications, along with Internet Assistants, allow users to develop web content without programming. They simply save their work as HTML, the way they would any other document. Such ease-of-use also extends to the newest member of the Microsoft Office family, the Microsoft FrontPage™ web authoring tool, which lets users create and manage entire web sites, even if they've never so much as programmed a VCR.

The Internet is very much a part of our BackOffice™ family, too. With Microsoft Internet Information Server, we've extended the performance of Windows NT Server to make the ideal Internet platform. Now every organization can host and manage web content and applications securely and reliably. And, with Microsoft Exchange Server, secure and reliable e-mail is also a reality, whether it's traveling over the Internet or within your organization.

The truly interactive web page has arrived as well...and with it, full motion video, audio and moving text. Advances made possible by technologies like ActiveX™ controls, which let developers embed sound, video, and applications without having to learn new languages.

Yes, the walls are coming down, but it's not the end of business computing. Just the next, most practical evolution.

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So if you're looking for a high-quality, color laser printer to go with your network, we have the system that is the solution. The C LBP 360PS from Canon. For more information, just call 1-800-OK-CANON. Or visit us on the Web at <http://www.usa.canon.com>

Canon

The Web-as-Platform Manifesto

We hold this truth to be self-evident: The Web is a platform. As such, it becomes the center of a universe, a gravitational force that attracts users and developers alike. Last year was the first time the Internet gave people a reason to buy PCs.

Although the Internet continues to be a factor, the 28.8-Kbps barrier has left a lot of users disappointed. Also, some of the content is long on promise but short on delivery.

As the local loop becomes digital within the next year or two, you'll leapfrog ISDN and be able to connect at anywhere from 300 kilobits to 6 megabits over your existing phone line. Faster line speeds will unleash a torrent of new content, which will require thousands of new servers and will sell millions more computers. Services will be speed-dependent, of course, but even the lower speeds will allow animation and audio to become commonplace. At the higher end will come videophones, interactive gaming, and video-on-demand MPEG movies. These next-generation apps will create a wave of new demand for hardware.

This Web thing is weird. People are falling all over themselves to learn HTML, install TCP/IP-based networks and Web servers, use browsers as front ends to everything in sight, and generally reinvent computing. It almost defies comparison. You can buy a perfectly good car from a Chevy dealer, complete with no-rust-through warranty and 50,000 miles before the first tune-up. If Web mania were to hit the auto market, we'd all be buying four tires, a bunch of metal, some seats, some glass, and a welding torch from Sears to build our own cars.

Instead of using off-the-shelf solutions, people are rolling their own from a dog's breakfast of dialers, protocol stacks, databases, browsers, and middleware. We're taking a giant step backward in performance, maintainability, and security, but who am I to stand in the way of progress?

Sarcasm aside, this bottom-up movement is a grab for more user control and a thumping rejection of "big" solutions. Of course, today's little solutions will become tomorrow's big solutions as the inevitable consolidations, mergers, and strategic alliances occur. Functionality will increase, but unfortunately, so will complexity.

For 1996, the \$500 Internet computer, or network computer, is a foolish pursuit, but it's an honest attempt by some of the moguls to turn the little solutions into big ones all the

sooner, taking the complexity away from the user and putting it back into the IS department, where it belongs.

There's no doubt that you can build a \$500 machine that will surf the Net, but the whole idea of loading your applications over the network is laughable, given the low speed of the local loop, crowded servers, and unpredictable backbone performance. Even applets, the small chunks of code promised by Java, don't mesh with most of our usage patterns. The whole idea of the network computer is not to store data locally. But can you imagine doing a spell-check over a modem linkup? Me neither.

The network computer begins to make sense in two scenarios. The first is when the line speeds go up and server performance begins to measure up to the tremendous load. The second is in business. We already have networks that deliver to our offices both bandwidth performance that we can only dream of at home and (usually) a sufficient amount of server performance.

Chances are, however, that even our last-generation equipment will outperform the typical network computer, so the argument remains weak. Of course, environments that require a high degree of security, control, or uniformity are prime candidates. These tend to be private networks that support point-of-sale terminals, factory automation, and secure systems. Will such applications be joining the tumult on the Web? I seriously doubt it.

Vendors such as Sun Microsystems are very good at the glib phrase, such as, "The network is the computer." *PC Magazine* has offered up a few good phrases as well, such as our wildly predictive T-shirt, circa 1987, that said, "If you're not connected, you're not computing." Both phrases are vastly more fitting today than when they were coined. Sun has offered up another one: "Java is the platform."

I don't think so. The Web is the platform, and Netscape is the chief embodiment of the Web. Java is a tool, no more, no less. Yes, it's a model of portability and a modernization of a thorny language (C++), but to call it anything else is wishful thinking. □



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Java: A Born Loser

It's hard to stand against the tide when everyone is boosting Java, but someone has to do it. Looking over the trends that have put personal computing on the fast track, I simply do not see where Java fits in. The major trend has been decentralization, and Java, in its purest form, runs counter to that.

For the most part, the promoters of Java come from a minicomputer mindset. Minicomputers have their place, but it's definitely not on the desktop. And I believe Sun, with a staff that is going gaga over Java, is basing its enthusiasm on a false premise.

At a recent Sun gathering, CEO Scott McNealy made an interesting observation about the direction of computing. The way he sees it, the world started out with big machines and quickly progressed to multiuser computing using the big machines. This evolved into minicomputers, with networks of users working off the minicomputers. Soon the microcomputer evolved and, with the rise of the Internet, followed the path of minicomputers, so that we have a central network again. In other words, in McNealy's estimation, things have essentially folded back a layer. The arrow of progress has reversed itself.

To me, this is disturbing. I don't believe that the evolution of personal computers would suddenly reverse course. Here's a more logical version of events: The world started out with big machines and quickly progressed to multiuser computing off the big machines. This evolved into minicomputers and LANs. Soon the microcomputer evolved, which continued to evolve away from the minicomputer model with the development of the WAN. In other words, personal computing has progressed from centralized to more and more decentralized: Mainframe to multiuser to mini to LAN to micro to WAN. This makes more sense. The next stage will be wireless computing and eventually radio frame-relay "cloud" technology. Each step takes us further away from centralization. There is no going back.

The notion that something like Java will come along and somehow magically reverse this trend is wishful thinking on a grand scale. Yes, Java will be used for dinky miniapps (writer/programmer Rob Hummel calls them "craplets") and as a way to add animation to stagnant Web pages, but not for much more. I do suspect that Java will

find some success as a way for programmers to write code for intranet applications. But it will hardly trigger a mass exodus from the current model for complex, application-oriented desktop computing.

When promoting Java, McNealy will tell you that a word

processor doesn't need more than five functions. This, to me, indicates he's ignoring yet another trend, the development of programs of increasing depth and complexity. Imagine a situation in which you have two word processors: One has 2,000 distinct functions, 1,500 of which you will probably never use; the second has only 1,000 distinct functions, 500 of which you will never use. Both are the same price. Which one will sell more copies? What if they are both free? Or if one is free? No matter how they are priced, users will pick the more complex product. It is a trend that cannot be ignored. Java attempts to throw this idea into the dumper.

And let's not leave good old Microsoft out of this formula. It has essentially thrown most of the company's resources at the Internet and even, in a panic, licensed Java. What do you think Microsoft, a company known for language development, is going to do about Java? I'd look for Visual Java, then Visual Basic/Java, then Visual Basic for the Internet, and who knows what else. Java will be eased out of the picture as fast as possible. Any creative use for a technology such as a network-centric language will come from end users, who seldom want to code in a C++ type of language, which is what Java boils down to.

Finally, let me just throw one more wet towel on Java by commenting on its utopian notion of machine independence. This desire for interoperability is a joke. What's the point if 90 percent of desktop computers are Intel machines? I had to laugh when someone recently said they would be doing special Intel-optimized extensions to Java. Sheesh, the thing hasn't even gotten off the ground, and the notion of machine independence is already threatened.

For all these reasons, the whole notion of a return to centralized computing with the Java language will degenerate quickly. It's simply too retro to become important.



OUT OF STEP

Each step takes us further from centralization. The notion that Java will reverse this is a fantasy.

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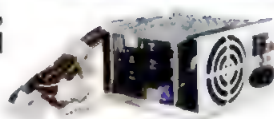
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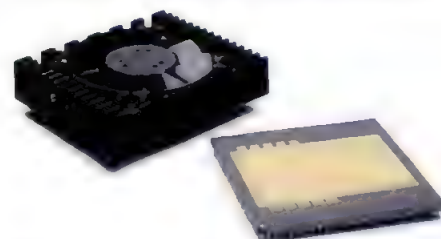
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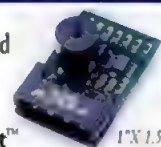
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Inside Track

What will happen to the **semiconductor business in the year 2000?** It will go through some terrible tribulations, for sure, as **the light wavelengths are all used up**—as in finito. Kaput. And it will be impossible to make chips with traces smaller than 0.2 microns. We're about to move from 0.35 to 0.25 microns and eventually to 0.2. The next jump from 0.2 microns is supposed to take place around the year 2000, and it will require a complete overhaul of process technology. X-rays will be used to make chips, but first, the entire infrastructure of the current technology has to be thrown out the window. The concept of masks, for example, is useless with X-rays, since X-rays penetrate everything. Then there are the safety aspects and other considerations. It's possible the transition may not be so smooth and the **entire industry will experience a hiccup** around the year 2000.

The Cable Modems Are Coming Dept.: Recently, Motorola announced that it would begin the **shipment of one million cable modems** to various sites, where the devices will be used on an experimental basis. People within the cable industry know **this is a crapshoot**. Smart, technology-oriented people are switching from cable to direct broadcast satellite by the thousands. This market loss is a major concern to cable companies.

Last year, I wrote a column in *PC Magazine* called "The Looming Cable Modem Fiasco" (September 12, 1995). Shortly after it was printed, I got a call from one of the engineers behind the cable modem scheme who **was steamed about what I had written**. He lit into me, citing facts and figures from lab studies that purportedly showed that the cable modem was going to be the hottest thing since sliced bread. I asked him for a memo outlining all of his points and told him I'd reconsider my position. After promising to send one, he hung up. (He was drunk, I might add.) I never received the memo, nor have I heard from him again.

One of the groups working on **cable modem technology is @Home**, which is funded by Kleiner Perkins Caulfield & Byers, a venture capital firm, and TeleCommunications Inc. (TCI). The start-up company tapped a **NASA superengineer** named Milo Medin, believed to be the guy who can not only **make the technology work**, but make it work on a broad scale. Will Hearst, ex-publisher of the *San Francisco Examiner* and chairman of @Home, has recruited a number of veteran designers and newsmen, including Roger Black and Mark Potts. Black is Hearst's drinking buddy and the guy best known for creating the logo for *Rolling Stone* magazine. Potts, Hearst's old business-section editor at the *Examiner*, is the typical newspaper-

*With high-speed access,
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as much time surfing
the Web. I wish the
cable companies luck.
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concept will work,
however, I still
recommend ISDN.*

man, with little interest in technology.

Insiders say that Hearst is looking to do **some sort of online newspaper**, while TCI only wants @Home to focus on getting the cable technology working. There appears to be **internal bickering** and other cable companies seem further along with all this than TCI. Then you have the personality of John Malone, head of TCI. Here's a guy who likes to control the content of his system. How is that mind-set going to jibe with the wide-open Internet?

Another issue comes to mind with the cable modem. If there is a set monthly fee, and if the access is faster than a T1 line—which proponents claim it will be—then everyone on the link will **use the system 24 hours a day** and set

up a server site at home (or, should I say, @Home). Fearing that the system, since it is a network, will get bogged down with everyone online all the time, @Home says people will be allowed to use its Web farm. I received a letter from a student complaining that when his dorm was wired with a high-speed network, the degradation problem resulted in access speeds much slower than what he could get from his 28.8-Kbps modem. This degradation problem is real and would occur if the system were a success. The cable companies, to live up to their performance claims, must actually **hope that the experiment is not too successful**—an awkward marketing goal.

On top of this, the typical cable infrastructure is simply not conducive to this type of service. Nevertheless, it is technologically possible, and we could use the speed. Research has indicated that with high-speed access, **people spend twice as much time surfing the Web**. They see a lot more of everything and enjoy the experience much more. I wish the cable companies luck. Until they prove the concept will work, however, I still recommend ISDN.

Online Everywhere Dept.: Let's not forget the online services and their impressive growth. **AOL** is pulling in 300,000 new subscribers each month, while **CompuServe** is getting 200,000 newbies per month. It's staggering. According to Jupiter Communications, the **number of U.S. households** with connections to consumer online services will increase from an already bloated 9.6 million in 1995 to a **whopping 35.2 million by the year 2000**. Sheesh. Make no mistake, you can put the thanks for this growth on the doorstep of the GUI and the 28.8-Kbps modem. This sure wouldn't be happening in a DOS world at 2400 baud.

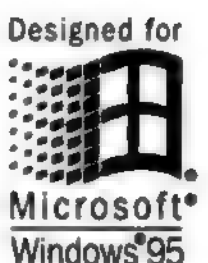
New Web Site of Interest Dept.: For all you game-playing DOOM nutballs, you'll be pleased to know that the new version of id Software's Web site is up and running. Check it out at <http://www.idsoftware.com>. □

O'Hare Airport: 4.3 miles of terminals.

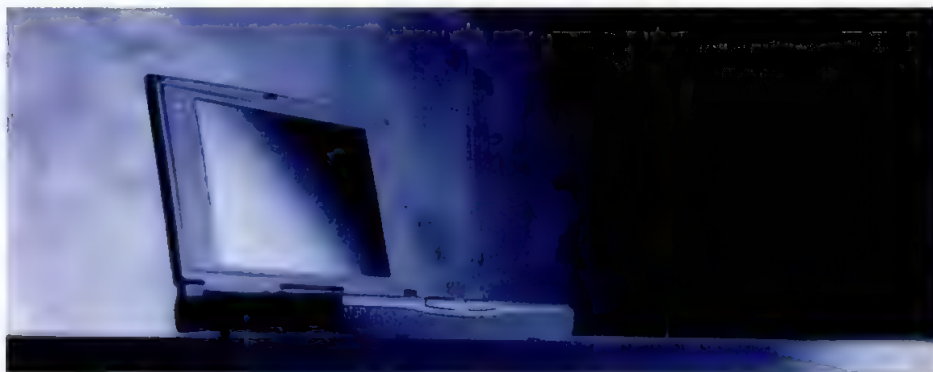
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(It occurred to us you might want a lighter notebook.)



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PointCasting the Future?

Be still my foolish heart. I recall muttering those words to a friend sitting next to me when I first saw the PointCast Network running on a PC. For a longtime, self-confessed news junkie like me, this was heaven: a nonstop newsfeed, right on my own screen,

comprising the latest Reuters headlines and stories, plus weather maps and a ticker-tape display of almost-current prices of selected stocks. Best of all, it was free! Suddenly, the Web opened up for me and revealed why it had been created. Thank you, Tim Berners-Lee, even if you never had anything like this in mind when you dreamed up the World Wide Web.

Like many cases of love at first glance, however, mine has faded a bit. Over time, I've grown irritated with PointCast's slow updates, and I am often infuriated by its ugly, intrusive ads, which are ever-present parts of the display. Even so, I still keep PointCast running on my primary desktop PC.

But there's more to this story than just an appealing new application, more than just a new way to use a PC. It's hard to deny the seductiveness and probable success of PointCast. But there are darker questions that must be asked about the nature of its "narrowcasting" approach, about its role in offices, about its effects on society and on business productivity.

You can download PointCast's proprietary software from <http://www.pointcast.com>, install it on your PC, and set up your own personal profile of interests—what kind of news you want to follow, which industries and companies interest you, cities for which you'd like to get weather forecasts, securities you want to track, and so on. PointCast uses your existing Web connection to download that information. Updates can be automatic; just choose how often you want your news refreshed. The results can be shown as a screen saver; after *x* minutes of inactivity at the PC, PointCast's elegant display pops up and the information you specified starts rolling by. Or you can use PointCast (less effectively) as an application itself, running in its own window.

Even if you don't share my news-junkie proclivities, I urge you to download the software and try it for a few days. Not to experience PointCast is to miss one of the most interesting and important developments in computers this year. Besides, it's fun to play William Randolph Hearst (though it's the former Adobe, Lotus, and Ziff-Davis ex-

ecutives who formed PointCast who are likely to get the California mansions out of this, not you).

The media attention paid to PointCast reveals how strongly this notion of narrowcasting, as opposed to traditional broadcasting, has taken hold. One of the favorite buzzwords of the post-McLuhan communications gurus who like to pretend the idea is new, *narrowcasting* simply means delivering a targeted, uniquely selected set of facts to each member of an audience, rather than broadsiding the entire audience with the same package of information.

Magazine publishers have been doing this for a long time, of course. Bill Ziff, the former head of Ziff-Davis, propounded the narrowcasting theory three decades ago, raising it to an art form by creating a huge stable of highly successful special-interest magazines aimed at pilots, skiers, and others. The magazine you hold in your hands is a product of that vision. Using readership surveys and advanced split-run printing and binding technologies, publishers have been able to further customize the products they deliver, so that subsets of their readerships get different editions of their magazines.

But there are limits in the physical world to the granularity of that customization. Clearly, each one of *PC Magazine's* 1,107,187 subscribers could not get his or her own, unique, self-selected custom edition of the magazine. But in the virtual world of electronic publishing,

that's easy. And this is the idea behind PointCast.

It builds on the company's earlier Journalist product, which lets you construct your own formula for a personal daily newspaper and then goes online, rounds up the information, and does a crummy job of laying it out on pages you can print. PointCast discards the problems of formatting for print and delivers a richer brew of information than Journalist ever could.

So what's wrong with that?

Does it give you pause—maybe even the creeps—to think about each of us defining so concretely the spheres of our interests? Pick up a daily newspaper and you'll read



CUSTOM NEWS

There are darker questions that must be asked about the nature of narrowcasting.

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JIM SEYMOUR

about, or have a chance to read about, all sorts of things you never knew existed. Even if you're a determined, read-only-your-own-narrow-interests sort, you can't help but be seduced occasionally by a teasing headline: "Biologist Discovers Possible Cancer Cure in Household Dust."

But if you're the one making up that newspaper, according to a narrow list of topics of interest, you're not going to see those headlines. You may get superb coverage of the semiconductor industry, but you're not going to learn about displacement of native peoples in rain forests or a hot new performance artist who uses lemons and motor oil in a clever way.

"So what?" you say. "This way, I get what I want, what I already know I want. After all, who knows me better than I do? And I get it efficiently and cheaply."

My answer: You're missing a lot, and you're the poorer for it. For that matter, society as a whole is the poorer for it, and over time, we may all lose—discarding important values and the breadth that informs and defines our culture.

Another worry about PointCast concerns how it fits into business. It's easy to imagine someone in an office setting up PointCast on his or her PC, loving it, and quickly proliferating it across the entire office. PointCast even includes proxy-server designations to avoid the bandwidth problems that would ensue if hundreds of us in the office went out on the Net every 10 minutes to update our personal news universes.

And it certainly seems cool to have everyone in the office always up to date and well informed on the day's news.

But what does that do to productivity in that office? We assume it would be perfectly okay to have a newsfeed running all day on our PC displays, so we can stop working and read the news. But would it be okay for an employee to keep a copy of the *Daily News* spread out across his or her desk and stop every few minutes to read it? Is there some essential difference in getting baseball scores, Cleveland's weather, and the latest Hollywood gossip electronically as opposed to on paper? Is it nobler to read about Dennis Rodman and orange-juice futures on-screen rather than on paper? Does work time lost to following the breaking Unabomber story somehow not count?

Will bosses be able to follow this logic? As a boss, do you want to pay your people to read the news?

Just asking. □

Frontiers of Benchmark Testing

In the PC industry, the anything-goes, shoot-'em-up spirit of the wild West prevails. For that, you can thank the graphics board vendors. They make good products, but they spend altogether too much time sniping at one another, criticizing their

competitors' technologies, looking for shortcuts to better performance, and feuding with reviewers and test labs. I believe the products would be better if the vendors redirected some of that energy toward positive efforts, such as working on better boards and cleaner drivers.

Two years ago, I first visited this issue in my column "Memo to Vendors: Cut It Out!" (April 26, 1994). Six months before that column appeared, we had revised our Graphics WinMark tests, and the updated test results yielded numbers that were markedly lower across the board. So a couple of vendors who came close to achieving scores of 100 million pixels per second on the previous year's tests kept reporting and advertising the old scores, simply because they liked the idea of surpassing a nice even number such as 100 million. That's why we now append the year to the names of most of our test programs (Winstone 96, Graphics WinMark 96, and Disk WinMark 96).

Even though that problem no longer exists, others have since arisen. Here's some background on our most recent testing of 2-D and 3-D graphics boards, the results of which are reported in this issue in "The High and Mighty."

During our testing, one problem we came across involved GDI (graphical device interface) patching—a method of hot-rodding graphics boards. Like soup-ing up a car, GDI patching can lead to unreliable results. Sometimes the car goes faster, but other times it breaks down. In this case, the vendors bypass certain GDI functions under Windows 95, resulting in a graphics performance boost of 10 to 15 percent. Note that this doesn't mean your PC runs 10 percent faster overall; graphics, of course, is only one aspect of overall system performance.

What makes it all the more interesting is that vendors who do patch GDI calls apparently wait until after the board is tested by Microsoft and certified as Windows 95-compatible. As we wrapped up the story, Microsoft had yet to make any official statement regarding the practice. But the preliminary indication from Redmond was that GDI patching isn't acceptable, because it can make your system less stable.

If you ever played Battleship as a kid ("I'm firing at grid B4," "You hit my battleship!"), you'll appreciate what happened next. We called the vendors who appeared to be bypassing the GDI. Here's the response from one (more or less verbatim): "We were planning to tell you, but we were wait-

ing for you to call and ask, because we wanted to know how you felt about it." In other words, they figured they'd tell us if we hit their battleship. The upshot: Vendors who do this have now agreed they'll include a method that lets you enable or disable the GDI patch.

Then there was the problem with the vendor who advertised OpenGL support. OpenGL is a precise 3-D rendering technology that's important for CAD software and 3-D visualization (as opposed to 3-D for games, in which speed is all that matters). The more we tested, the more it looked as if the board actually ran slower than if you just let the operating system (Windows NT, in this case) take care of the functions. The vendor said maybe we weren't running the tests correctly. PC Labs has made a few mistakes in the past, but we didn't think we were in the wrong here. The vendor finally 'fessed up, admitting the driver doesn't work. The company offered us a trade: If you stop testing OpenGL performance, we'll issue a statement that our driver is defective.

Virtually every major graphics board vendor has been in the PC Labs doghouse at sometime over the past several years, including ATI, Diamond, Matrox, and Number Nine. They weren't cheating; let's just say they were trying to push their advantages a bit too far. This time around, it was Matrox more so than the others—the same company that had the OpenGL problem. Now here's the irony: For mainstream power users, bad boy Matrox Millennium also happens to have the best all-around board. That just goes to show: Even when we're annoyed with a company's sophomoric and counter-productive antics, we're still big fans of superior power, performance, features, and bang for the buck. And that's why the Matrox board won our Editors' Choice as the best 2-D graphics board. □



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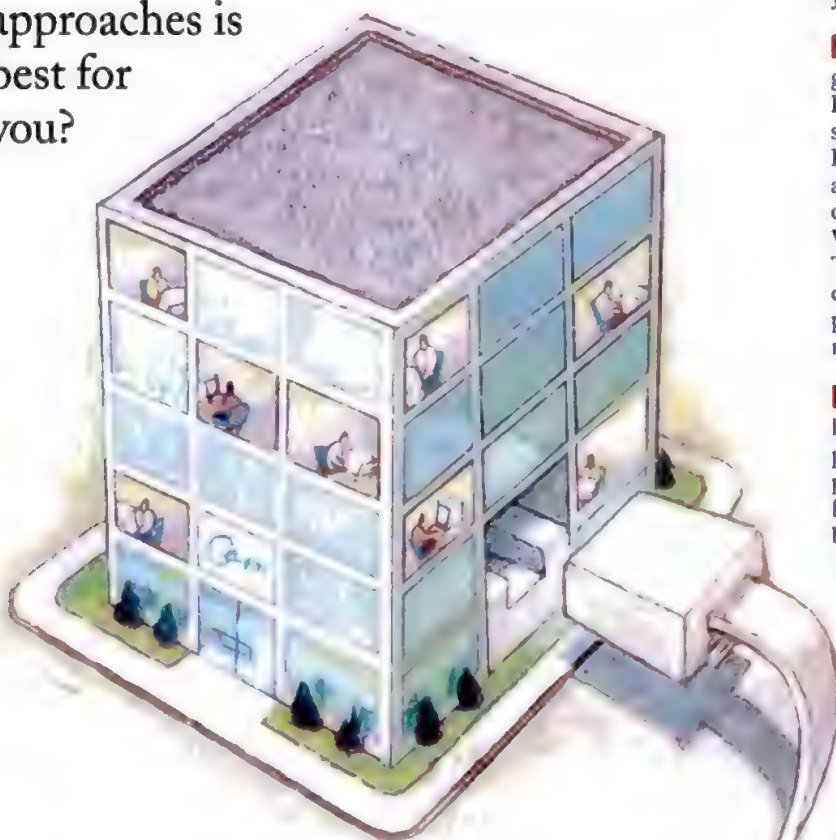
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The New Ethernet

It's not your father's Ethernet. Today you can choose from 10-Mbps switching and 100-Mbps solutions. Which of these approaches is best for you?



By Frank J. Derfler, Jr.

You can't just say "Ethernet" anymore. Bandwidth-chewing video and audio applications, banks of high-speed WAN connections, and the need to segment network traffic are driving changes to the familiar Ethernet. Companies such as Kalpana (now part of Cisco Systems) and consortiums such as the Fast Ethernet Alliance created technologies and products that embroider new

INSIDE



Deciding when to make the move to a faster technology is one of the trickiest decisions in network computing. You're betting that some new (and cheaper) approach isn't going to supplant your latest hero as soon as you slap down your money.

IN THIS ISSUE, WE GIVE you some guidelines on when and how to adopt Fast Ethernet, the hottest-selling high-speed networking technology. Frank Derfler, our senior networking editor and all-around connectivity guru, lays out the decision-making process. Whether you should go with 100Base-TX or -T4 or -FX is largely a function of the quality of your installed cable plant and your current and anticipated needs.

IN FIRST LOOKS, JEFF WITT, the project leader who runs testing for our big comparative network roundups, reviews a product that could be a harbinger of future networking. DirecPC is a satellite-based WAN solution for connecting your PCs to the Internet or to other businesses. (NE 23)

STEVE BUEHLER, DIRECTOR of PC Labs, West Coast, gives us a first look at NetWare 4.1 SMP. He says it's evolutionary, so don't expect revolutionary performance results on file and print services. (NE 26)

ALSO CHECK OUT ROB LIPSCHUTZ, tech director/networking, in Multiple Access this issue for advice on some new tools you should have on hand to help you with your fast new pipes and connected users. (NE 17)

—Gail Shaffer

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capabilities into the proven Ethernet fabric. The bag of tools and technologies that we call the New Ethernet provides options that can incrementally and economically meet the needs of data-driving applications in LANs of all sizes.

The elements of the New Ethernet include switching, 100-Mbps adapters and hubs in two basic types, and a competing technology called 100VG. It's not technically correct to call ATM a relative of Ethernet, but ATM certainly extends and augments Ethernet LANs. Our sidebar, "Previous Articles on Fast Networking," guides you to reviews of related products that we've done over the past few months. And visit the Network Edition section at our Web Site, <http://www.pcmag.com>, for a complete listing of 10-Mbps switches and shared 100-Mbps hubs

SWITCHING DATA

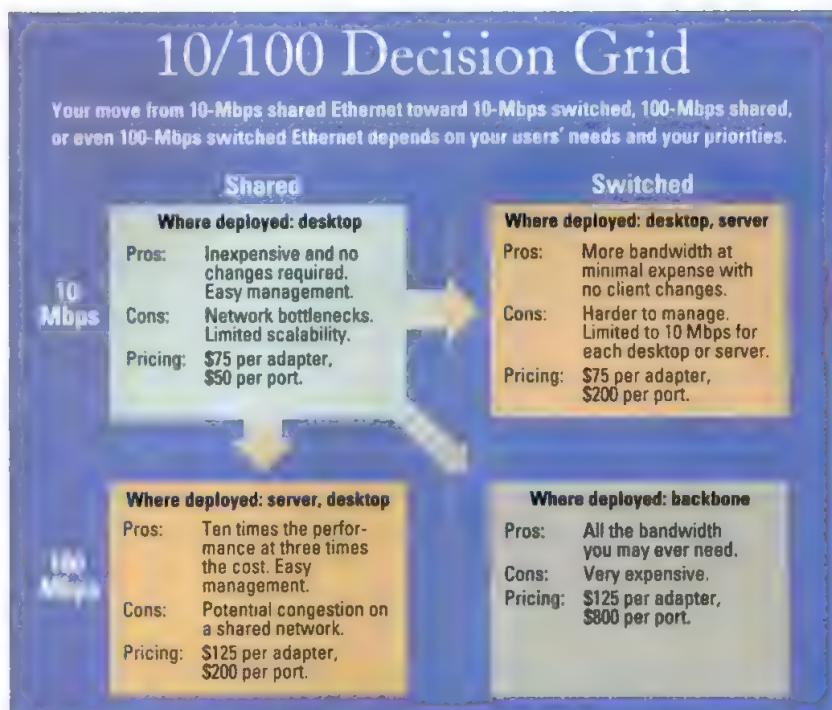
The easiest way to improve the throughput for high-traffic nodes like graphics workstations and servers is to replace the hub in the closet with a switched Ethernet hub. Switches allow each node to use the cable without contention because they buffer incoming data and then send it out to only the designated destination node when that node's outgoing port is open. In effect, a switch changes Ethernet from a contention broadcast system to a direct delivery system. The benefits are immediate and you don't have to make any changes to the cabling system to benefit from switching. Importantly, switching also benefits PCs with ISA bus and laptops with PC Card LAN adapters—computers that can't benefit much from fast connections.

Switches are available for both 10-Mbps and 100-Mbps Ethernet. The 100-Mbps switches find particular value as a traffic control point for the connections between a cluster of servers and multiple workgroup LANs. If you have throughput problems, think 10-Mbps switches first.

THE 100-Mbps OPTIONS

While 10-Mbps switching is a basic building block of improved performance, some systems need more. If you have high-performance LAN nodes, including RISC-based, Pentium, and Pentium Pro computers, then they can take advantage of the throughput offered by 100-Mbps LAN adapters, hubs, and switches. You really need computers with the PCI bus or Sun's S-bus to get much benefit from 100-Mbps schemes.

Our testing for this issue focus on an emerging and useful set of products: 100-



Mbps adapters and hubs, called 100Base-T4, that can use the same type of LAN cable originally installed for 10Base-T equipment. In case you need high throughput connections—even for a few nodes or a sub-LAN in an existing system—these 100Base-T4 products can provide them.

Three specifications for Fast Ethernet control today's market: 100Base-TX, 100Base-FX, and 100Base-T4. Another slightly different specification, called 100VG, is a competitor to the Ethernet family. The key difference among the 100-Mbps products is in the kind of cable they use, and cabling availability and investments will control your use of each technology.

The 100Base-TX products depend on a high-quality cable installation that meets the standards called Category 5, established by the EIA/TIA and other certification organizations. In many cases, this requirement means that you need to pay for a new cable system installation if you want to move from 10Base-T to 100Base-TX.

The 100Base-FX specification calls for fiber optic cable. The 100Base-FX systems shrug off radio frequency interference and can extend connections out to over a mile of cable. Although many applications justify their cost, the pieces and parts for a fiber installation are costly. For example, a new fiber-cable installation can be two or

three times as expensive as that of a new Category 5 cable installation. 100Base-FX has gained acceptance in finance, energy production, and other application areas that can pay for top performance and reliability. In more humble venues, its long-distance reach makes 100Base-FX a good LAN backbone technology.

But both 100Base-TX and 100Base-FX can drive costly LAN cable system upgrades. Adapters conforming to 100Base-T4 can operate over any Category 3, 4, or 5 copper wire. This flexibility allows network managers the ability to offer 100-Mbps LAN connections no matter what cable plant is installed. But are you getting something for nothing? No, clearly not. 100Base-T4 requires four pairs of wire for each node to attain its speed over these cable types. Since LAN data cables only contain four pairs, you are betting that every wire and every connection in every cable is good. That's often a long shot.

Many of the 100Base-TX vendors are shipping or plan to ship adapters and hubs conforming to both specifications. Because 100Base-T4 uses the same Ethernet packets as the other 100Base-T solutions, no extra bridging hardware is necessary when mixing 100Base-TX and 100Base-T4 hubs in the same stack. Some 100Base-T4 hubs will integrate both 100Base-TX and 100Base-T4 ports to accommodate both technologies.

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Previous Articles on Fast Networking

Title	Date	Page	Author	Article type
The Greed for Speed	4/25/95	NE1	John Garriss	Technology comparison
Ethernet				
Stack Me Up	12/19/95	NE1	Padraic Boyle	Comparative review
Two Lean, Green Machines	9/26/95	NE52	Padraic Boyle	Hardware review
We Hear Ya!	4/25/95	NE46	Frank Derfler	Column
Eliminating the Bottleneck	3/14/95	NE18	Steve Rigney	Hardware review
Fast Ethernet				
Shifting into High Gear	12/19/95	205	John Garriss	Hardware review
FastSwitch: The Next Generation	11/7/95	NE17	Padraic Boyle and Michael Ryan	Hardware review
First Stackable on the Fast Track	10/10/95	NE20	Arun R. Desai	Hardware review
Fast Ethernet, Fast Track	9/12/95	NE44	Robert P. Lipschutz	Column
King of the Hill?	6/13/95	NE24	Charles Lin	Hardware review
New Reasons to Go Fast Ethernet	4/11/95	NE15	Shawn Kafaipour	Comparative review
100VG - AnyLAN				
Riding the First Wave of 100VG	9/12/95	NE21	Padraic Boyle	Hardware review
ATM				
ATM on the Move	4/23/96	NE1	Robert P. Lipschutz	Comparative review
ATM Comes to the Fore	4/25/95	NE19	Robert P. Lipschutz	Hardware review
Cable Testers				
LANMeter Moves Beyond Wires	5/14/96	NE52	Steve Rigney	Hardware review

THE 100VG ANYLAN ALTERNATIVE

Fast Ethernet is not the only 100-Mbps LAN technology available. Hewlett-Packard and a few other companies offer products conforming to a technology called 100VG (100 voice grade) AnyLAN. The primary advantage of 100VG is a feature called Demand Priority Architecture (DPA). 100VG transmits data over four pairs of UTP, but DPA provides a way for some applications, such as videoconferencing, to get priority service from the hub.

KNOW YOUR CABLE SYSTEM?

If you want to use any fast networking scheme other than switching, you must know a lot of details about your installed or planned cable system. Both 100Base-TX and ATM require a Category 5 cable installation. If you have an investment in Category 3 cabling, you still need a detailed survey of your cable system to insure that you have enough pairs of cable going to the right places.

A cable system is a lot more than just the wire. Standards such as Category 3 and Category 5 define the resistance to signals leaking between pairs—called near-end crosstalk (NEXT)—and the ability of the wire to pass signals at different frequencies—the frequency attenuation curve.

Everything in the path from the client adapter to the wiring closet, including punch-down blocks (if installed) and patch panels and patch cables, which make up the cabling plant, must adhere to the standards.

If any of these pieces is not up to snuff, then be prepared to deal with some network problems. Simple things make big differences; for example, installers might unravel the twisted pairs too much, degrading the signal and reducing the electrical cancellation between wire pairs.

Without knowing the quality of your cable plant, you can't make an informed decision about what Fast Ethernet solution is right for your installation.

SO HOW DO YOU KNOW?

As with most things, you can either hire somebody to do it or do it yourself. If you want a new Category 5 or fiber-optic cable installation so you can use 100Base-TX and 100Base-FX, you'll want to use professional installers. Make sure, though, that they provide you with documentation such as wire maps and profile curves—printouts showing the near-end crosstalk and attenuation.

But, if you want to use 100Base-T4 or 100VG technology, you can probably do the survey yourself. You'll need a cable tester from a company such as Fluke, Microtest, or Scope. The testers will show you whether your installed cables meet Category 3 or 5 specifications. But most importantly for 100Base-T4 and 100VG buyers, they'll tell you if all the cable pairs are available and in the right order in the plug. Out-of-order and crossed pairs are common problems.

The following reports and tables provide you with the tools to make some smart decisions from the world of the New Ethernet.

10/100 Adapters

ALL SECTIONS BY PADRAIC BOYLE

Fast Ethernet is here to stay. Even if you do not plan to install it soon, you should think seriously about purchasing a Fast Ethernet adapter. Better known as 10/100 adapters, these products are designed with both 10-Mbps and 100-Mbps silicon onboard. This allows you to buy now and easily upgrade your LAN later by merely replacing the hub or switch in the wire closet with a Fast Ethernet hub or switch. With pricing comparable to 10-Mbps adapters, buying Fast Ethernet adapters now is a good idea.

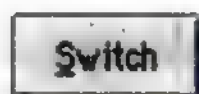
Besides offering two speeds, a majority of Fast Ethernet adapters come with drivers and provide a single port with the capability to switch or negotiate automatically between 10-Mbps and 100-Mbps connections without any modification on the client side. Unfortunately, some 10/100 adapters provide two separate ports, one for 10 Mbps and the other for 100 Mbps, requiring you to visit each client and manually change connections.

When we put these adapters to the test, we found that a 1K block size rendered an average throughput of 70 to 75 Mbps between the server and multiple clients. One problem we observed was that some adapters relied almost 100% on the CPU, hindering its ability to perform other functions for the NOS. SMC EtherPower 10/100 PCI, for example, moved 1K blocks of data at 77 Mbps with 96% CPU utilization compared with Intel's EtherExpress PRO/100 PCI adapter's 76-Mbps throughput and 52% CPU utilization. We found that an adapter's driver sophistication can greatly affect performance and CPU utilization numbers. In short, the better the drivers, the better the numbers.

Many of the today's servers come with PCI and EISA buses. We found that PCI not only performs better and has lower CPU utilization, it costs less (\$169 compared with \$299). Considering its speed and flexibility, we feel the PCI-dominant bus structure is superior to EISA. For servers that offer only three PCI slots, adapters such as Cogent's EM400 TX Quartet offer four individual 10/100 ports on one adapter.

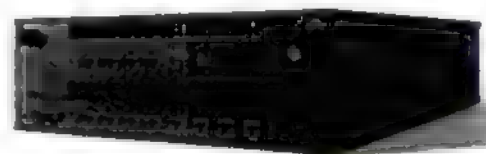
There are two dozen or so adapters on the market, but we especially liked Cogent's EM110 TX, Intel's EtherExpress PRO/100 PCI, 3Com's Fast EtherLink 10/100 PCI, and the ZNYX NetBlaster ZX342. Each adapter comes with a wide array of NOS support, including Artisoft

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ATM
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nice.
But it
also
sounds
pretty
darn
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IBM presents the first affordable 25Mbps ATM Workgroup Solution. Everyone is talking about ATM as the answer for speeding up busy networks. But there are two good reasons why business hasn't stampeded en masse to the ATM solution: It costs a lot. And to get there, you have to rip out everything you have.

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HOW WE TESTED

100Base-T4 NIC



We tested three PCI 100Base-T4 adapters hot off the assembly line. They performed about the same as the 100Base-TX adapters we tested last year, and CPU utilization was a differentiating factor. In this early look, Cogent's adapter was the leader.

What the Numbers Mean

Throughput and CPU utilization are the two major gauges of performance for a network adapter. Higher throughput means data is transmitted faster between client PCs and the network; lower CPU utilization means the adapter does not steal too much of the CPU's processing time from other apps.

On our test transferring 64-byte packets, all three adapters performed similarly, although 3Com's throughput and CPU utilization scores trailed Cogent's and Racore's slightly. The numbers began to skew at 1K, with Cogent and Racore performing similarly and 3Com lagging behind.

When we pushed the server adapters toward their performance limits at 32K, Cogent, with steady high throughput and low CPU utilization, outran Racore and 3Com. The Cogent adapter's results were similar to those for the Intel EtherExpress PRO/100B 100BASE-TX adapter, which earned our Editors' Choice in last year's testing ("Shifting into High Gear," December 19, 1995).

The hardware chip set and software drivers play a crucial role in determining a network adapter's performance. The 3Com Fast EtherLink was equipped with a proprietary 3Com Parallel Tasking 40-0282 chip set; the Cogent eMaster+ EM110 used a Digital 21140-AB chip; and the Racore M8149-040 came with a Texas Instruments ThunderLAN TMETE 100.

Although the chip set determines the basic performance of an adapter, an optimized software driver that takes full advantage of the chip set can improve final performance. This is why two network adapters from different companies with the same chip set sometimes perform differently.

It's a good idea to download and use the most up-to-date drivers from your adapter company's BBS bulletin service or Web site. A newer version driver generally is more bug-

free and optimized for performance.

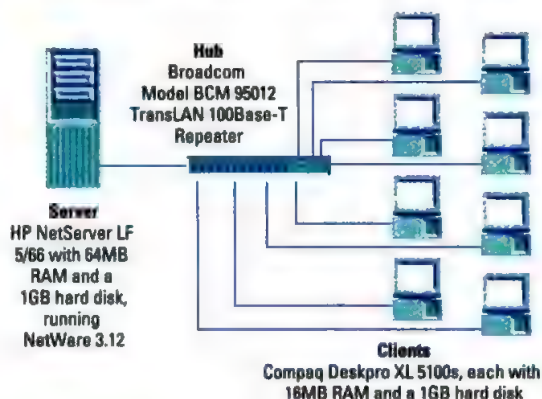
All three adapters in this group support 10/100 dual-speed auto-sensing and bus mastering. Bus mastering lets the adapter access the computer's memory and resources independently of the CPU, thereby decreasing CPU utilization.

—Analysis written by Alex Ho

How We Tested

We set out to evaluate three new 100Base-T4 Fast Ethernet PCI adapters. We tested the adapters using our Ziff-Davis Benchmark Operation's NetBench 4.01.

We connected the server and clients over Category 4 UTP cables via two eight-port Broadcom TransLAN 100Base-T stackable Ethernet hubs. According to a Fluke DSP-100 LAN cable tester, our Category 4 cables had an average of



TEST-BED DIAGRAM: 100Base-T.

66.7 dB crossover isolation when running at a 12.5 MHz frequency, and 0.3 dB attenuation at 12.5 MHz.

To create our **NIC Performance/Efficiency Index** we tracked the server's CPU utilization by running Novell's STAT.NLM during our test. Each adapter's index score then was calculated by dividing the server adapter's throughput by the recorded CPU utilization.

We tested each adapter using packet sizes of 64 bytes, 1K, and 32K (the same test sizes we used in last year's look at 100Base-TX adapters). Though a typical packet size is around 4K, we revved up our tests to 32K in order to observe the strengths and weaknesses of these products under pressure. A product that does well at 32K probably has a more efficient adapter processor all the way around.

	64-byte blocks		1K blocks		32K blocks		
	NIC Throughput Mbps ▲	CPU Utilization Percent ▼	NIC Throughput Mbps ▲	CPU Utilization Percent ▼	NIC Throughput Mbps ▲	CPU Utilization Percent ▼	NIC Performance Efficiency Index* ▲
Cogent eMaster	8.17	93	74.8	51	81.0	24	3.4
Racore M8149-040	8.27	96	70.3	54	67.0	40	1.7
3Com Fast EtherLink	6.89	97	65.1	86	84.1	68	1.3

* NIC Performance Efficiency Index numbers are calculated by dividing the server adapters' 32K NIC Throughput scores by the 32K CPU Utilization scores.

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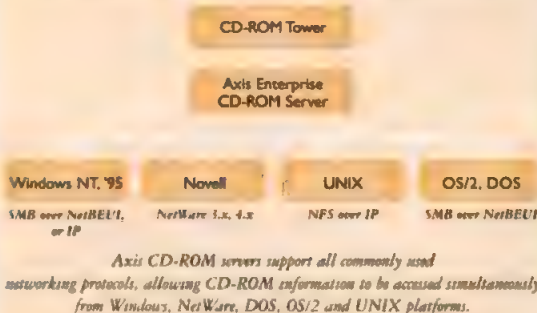
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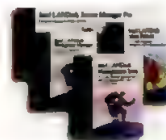
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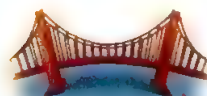
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With their double speed capability and competitive pricing, Fast Ethernet adapters are a no-brainer purchase for your network. The trick is to buy the right adapter. Look for one that provides a single port for automatic switching and make sure that it doesn't rely too heavily on the CPU. When it comes time to switch to Fast Ethernet, having this groundwork in place will make the transition easier.

10-Mbps Switched Hubs

Switched Ethernet is one of the cheapest and easiest ways to extend the life of your 10-Mbps Ethernet LAN without overhauling your network. With prices ranging from \$200 to \$250 per managed port, switched Ethernet hubs are an excellent solution for departmental or workgroup LANs that communicate with a small group of servers. It's as easy as replacing the Ethernet hubs in the wire closet with a switching hub.

These switches do not necessarily have to replace a hub port-for-port. And switches can be used for segmenting workgroup hubs from the rest of the network or for setting up a dedicated 10-Mbps pipe to a server that caters to a select group of clients. Switching also provides bidirectional capabilities, allowing clients to transmit and receive data at the same time, for a total throughput of 20 Mbps.

You have a lot of choice among the large number of vendors in this market, both in pricing and feature sets. You can choose among a range of port densities, high-speed port options, management capabilities, and virtual LAN (VLAN) capabilities.

Fast Ethernet ports can be used for switch-to-switch or backbone installations and should be able to operate in full-duplex mode. Full-duplex enables the Fast Ethernet pipes to provide for effectual throughput of 200 Mbps between the switch and the server or between two switches. If you dabble in VLANs, you can logically break out the ports on the hub into several separate LANs via the management software. This is particularly useful for segmenting networks and controlling broadcast traffic. Among the many vendors with switches on the market are Bay Networks, Cabletron, Cisco, and 3Com.

Bay Networks' BayStack Ethernet Workgroup Switch offers 6 switched 10-Mbps ports (800-822-9638). Unlike many other switches, though, it has only one op-

tional uplink connection available for connectivity to higher bandwidth technologies such as Fast Ethernet. Like the 3Com switch, this BayStack switch has centralized management—under Bay's Optivity.

Cabletron's FN10 Ethernet switch is available in 12- or 24-port models (603-332-9400). The FN10 has two optional Fast Ethernet ports (\$3,185 for two TX ports; \$3,895 for two FX ports).

The \$6,295 Catalyst 2100 from Cisco provides 25 10Base-T ports and two Fast Ethernet ports (800-553-6387). In addition to port switching, the Catalyst 2100 also supports up to four VLANs. It offers workgroups connectivity to Fast Ethernet over UTP or fiber cabling. This switch can be controlled from a central management station with Cisco Works, a series of SNMP management applications.

3Com's SuperStack LinkSwitch 1000 hub is a switch solution with 12 or 24 Ethernet ports (\$3,975 and \$4,975, respectively) and up to two 100Base-T ports, which can be UTP or fiber optic cable (800-638-3266). The LinkSwitch 1000 carries all the benefits associated with being a part of 3Com's SuperStack solution. This includes a redundant power supply and Transcend, 3Com's SNMP management software. If you're looking for VLAN support, however, you may want to look at the Catalyst 2100 from Cisco Systems.

Each of these vendors and many others offer a full range of Ethernet switching hubs and other hubs that interoperate to create network solutions for small workgroups and larger corporations.

100Base-T Hubs

If you're in design or redesign mode and intending to build higher bandwidth into your network, one possible solution is to use shared 100Base-T hubs. Shared hubs certainly provide high-performance networking between desktops and servers in a workgroup environment. They create a shared environment at ten times the bandwidth of 10 Mbps.

But beware that the 100-Mbps bandwidth carries a few limitations. The maximum run supported for 100Base-T is (theoretically) 250 meters—one-tenth that of 10-Mbps Ethernet. Moreover, Fast Ethernet switches can be cascaded only once between network hubs. Standard Ethernet hubs can be cascaded three to five times. You can overcome these limits by deploying stackable hubs and switches, and thereby install Fast Ethernet on a large scale.

Some of the distinct features of

100Base-T hubs are port density, management capabilities, and pricing. Scalability is probably the most important factor when selecting a hub. Management capabilities are necessary for tracking network traffic and problems when they arise. Here are just a sampling of the Fast Ethernet products from which you can choose.

For small workgroups, with fewer than 30 clients, Cisco Systems offers its family of nonstackable FastHub 100Base-TX hubs, which are available with 4, 8, and 16 unmanaged ports (\$995, \$1,595, and \$3,195 respectively). Other members of the FastHub 100 family include the 12-port 100Base-FX and 15-port 100Base-TX, which has one FX port to connect switches over fiber. Cisco has no management package, but MIBs are available to any SNMP-compliant package.

3Com's SuperStack LinkBuilder FMS 100 hub offers 12 100Base-TX ports and an optional media-flexible port for \$2,899. The LinkBuilder FMS 100 reaps many benefits as a part of 3Com's SuperStack line of stackable hubs: a redundant power supply, an optional management unit that offers full SNMP capabilities, and Transcend management application support. 3Com will be shipping the LinkBuilder FMS 100 T4 hub, with 12 ports (\$2,388), later this year.

Intel's stackable Express Stackable 100Base-TX hub (\$2,395) has 12 ports with an optional management module (\$2,295), which provides SNMP support for the entire six-unit stack (800-538-3373).

A more flexible solution is the Bay Stack 100Base-TX hub from Bay Networks. The two-slot chassis BayStack 100Base-TX hub is available with either 12 or 24 ports, (\$2,375 and \$4,370). And with a maximum of six hubs in a stack, the Bay Stack 100Base-TX lets you create a network of 144 unmanaged ports or 132 managed ports. The optional management module requires two slots in one of the stack's hubs. Then, you can manage the entire stack using Bay Networks' Optivity management applications.

The Cabletron HubStack series consists of multiple hub solutions, including the SEH100TX-22 (\$7,995) and the SEH100TX-22 (\$6,995). The 12-port hub is available as an intelligent or a nonintelligent component of the HubStack solution. As many as five nonintelligent hubs, or one intelligent hub and four nonintelligent hubs, can be stacked into a single unit, providing 60 ports. Network management is handled by Cabletron's Spectrum Element Management.

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See Chart Below Right			
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Ethernet Switching: What's Not to Like?

By Charles Lin

Not ready to commit to 100-Mbps Ethernet in any form but still need more bandwidth? You should give Ethernet switching a second look. This inexpensive upgrade can be all you need to sustain your network for years to come. Of the high-speed alternatives, only switched Ethernet lets you both keep your Ethernet infrastructure and introduce more bandwidth with almost no downtime.

Ethernet switching is the dynamic routing of packets without regard to protocols, which results in higher bandwidth. It's usually understood to offer a full 10-Mbps pipe either to each lucky, attached client or server, or to a hub with several clients. But you should assess your own needs first. If your network begins sustaining twice its average utilization, or if your average utilization runs at more than 50 percent of bandwidth, you're a good candidate for Ethernet switching. If your average utilization is low but reaches saturation when it's busy, you may need to go straight to 100-Mbps Fast Ethernet or 100VG-AnyLAN.

LAN SWITCHING VERSUS WORKGROUP SWITCHING

You can position the switch in one of two key places. You might put it on the network backbone, with hubs attached to each port. Used this way, the switch mainly divides the network into smaller collision domains, which keeps a busy segment from affecting other segments. The switch should accommodate a large number of MAC addresses for all those users. It also should have a high-speed port.

Sometimes called a department switch, the switch comes either as a chassis-based module or as a stackable unit. Chassis-based switches cost more, but they usually support more switch modules for a highly scalable system with redundant power supplies and central management. Stackables are more affordable and can grow as a business grows.

Workgroup switches support fewer MAC addresses but also are less expensive. They are ideal where, for example, you have a small group of users to segregate from the rest of the network because of their high network usage.

SWITCHING ARCHITECTURES

The two basic approaches to switching Ethernet packets are store-and-forward and cut-through. You can choose between the two based on a couple of issues, but don't do it on perceived performance differences. All of *PC Magazine's* previous switch testing has revealed that latency differences between the two results in no significant differences in performance. The only limitation seems to be Ethernet's maximum line speed.

That said, store-and-forward carries the most latency. The entire packet is checked before it is passed to its destination port. Most store-and-forward switches comply with

the Spanning Tree algorithm. This algorithm discovers the best path to each destination and stores it in the look-up table. Much like a bridge, the incoming frame is re-sent to the port specified in the look-up table. Store-and-forward also enables administrators to create a redundant physical network for security.

Cut-through starts forwarding the packet when the address is read. Although cut-through introduces little latency, retransmission of a packet is sometimes necessary after it reaches its destination, costing valuable network bandwidth.

Protocols that support packet burst will not benefit greatly from cut-through, because packets still are stored until a destination port buffer clears. Some vendors implement variations on these two themes, but the average user will not notice the difference in performance.

HIGH-SPEED OPTIONS

You'll want to secure a switch with a high-speed port, which can connect your switch to the network backbone or be used as a dedicated line to the server.

Many products offer 100-Mbps uplink or plug-in modules for FDDI and ATM. A 100-Mbps full-duplex port can make desktop video a reality without revamping the entire Ethernet infrastructure.

VIRTUAL LANs

More and more switch vendors are building virtual LAN capabilities into their products. Virtual LANs (VLANs) enable administrators to create logical workgroups of users via software to segment groups with high traffic from one another. It does help you manage your bandwidth and even pays security dividends, but virtual LANs are complex to manage.

A perfect VLAN will allow administrators to group users notwithstanding physical locations. Any group member can receive broadcast and security restrictions no matter how the data is routed. Not yet a mature technology, VLANs are nevertheless an area of network computing to watch.

CALL THE MANAGER

Managing Ethernet switches is not as easy as it may seem. If the packet doesn't find its destination, switches will make it more difficult to locate the problem. Network analyzers will not provide an accurate view in a switched port, because it is not a shared collision plane.

Every switching product offers out-of-band management, which may be fine for small workgroups. But if you can afford SNMP management, go for it. Most switches support SNMP agents with MIB II-compliant interfaces, so you can manage all of your devices from a central SNMP console using such software as HP's OpenView. MIB-II is used to gather statistics on the system and protocol. Most devices also offer in-band management via a proprietary Windows or DOS application.

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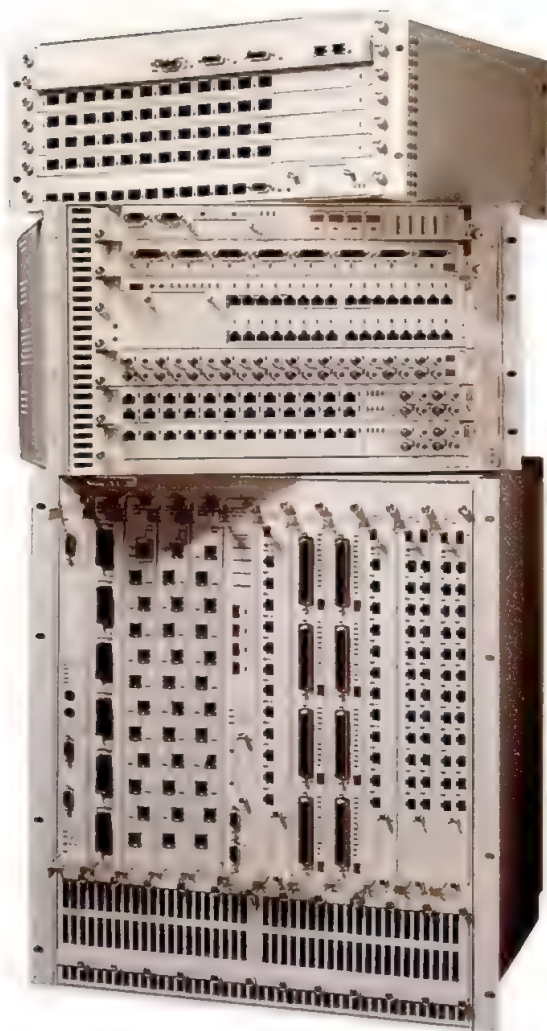
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The Building Blocks of Large Corporate Networks



The ODS Infinity Enterprise Switch Family

LAN/WAN Switching and Routing

The Infinity's switch chassis provides high-speed switching and routing modules for Ethernet, Token Ring, FDDI and ATM standard-based networks. The flexible design of the Infinity makes it the only enterprise switch chassis on the market that supports shared media modules, switched media modules, and routing modules all in the same reliable, fault-tolerant switch chassis.

Interchangeable Network Modules

The Infinity's family has three switch chassis sizes: a 4-slot for small sites of 12-192 users, a 7-slot for 12-366 users and a 12-slot for 12-576 users. The Infinity's networking modules are unique because they have a universal, re-deployable, scaleable and interchangeable design that is compatible with all three chassis sizes. This flexibility means that network managers only need to keep one set of spares for the entire network, reducing their network's cost-of-ownership by 66%.

Network Security

Security is one of the Infinity's strongest benefits. Network security is provided using several layers of protection. The Infinity uses encryption/scrambling features to provide a primary layer of defense. Additional layers are built using SNMP management and RMON capabilities. Security Logs can be built to record many different network events to a file that can be used any time to trace every packet to its originating physical port.

Advanced SNMP/RMON Management

In addition to security, the Infinity's management makes it possible to prevent network failures before they happen. The Infinity's management module provides better functionality than a protocol analyzer. Instead of sending several experts to different sites with analyzers to collect data after a problem has occurred, one expert can proactively perform a multi-segment, 7-layer protocol decode on data packets from a centralized location before a problem occurs.

No Single Point-of-Failure

The Infinity enterprise switch does not have a single point-of-failure. Each switch chassis has multiple backplanes that carry data traffic and a control backplane for out-of-band management traffic. Each switch module is slot-independent, which means the loss of one or more modules will not affect the rest of the network's operation. The switch also features load-balancing power supplies, redundant data paths and hot swappable modules.

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100-Mbps Switches

Can you never get enough bandwidth? Does it seem to take forever to transfer those memory-hogging multimedia files? One solution could be switched Fast Ethernet, which offers the best of both worlds if you can get over the sticker shock. Fast Ethernet hubs combine switching technology with the speed of Fast Ethernet to provide a dedicated 100-Mbps connection for a group of servers, workgroups, or high-powered clients.

Similar to a telephone system, switching hubs make a virtual connection between two ports and release the connection after the communication is completed. Switches are useful in extending the diameter of the Fast Ethernet LAN beyond the 250-meter limit and are a must when implementing large-scale Fast Ethernet installations. Because of its high price tag (\$800 to \$1000 per port), however, switched 100Base-T is primarily for backbone solutions or server farms that require large bandwidth.

Although 100-Mbps switched Ethernet is similar to 10-Mbps switched Ethernet in oc-

cupation, the 100-Mbps switch requires the Category 5 specifications necessary for Fast Ethernet. The Fast Ethernet switch requires more sophisticated and costly internal components to transfer data at a faster rate, which accounts for its higher price tag.

Features to look for in a switching hub are port density, management, full-duplex and VLAN (Virtual LAN) support. Fast Ethernet ports are used for switch-to-hub or -backbone installations, and full-duplex capabilities will allow the Fast Ethernet to transmit data at 200 Mbps between the switch and the server or between switches. In conjunction with your management software, VLAN can divide the ports on the hub into several separate LANs. This is particularly useful for segmenting networks and controlling broadcast traffic.

Intel's Express Switching hub (\$4,995) offers five 100Base-TX switched ports plus two additional option ports that accommodate 100Base-TX (\$1195) or 100Base-FX (\$1495) expansion modules. A Microsoft Windows-based package is coming.

The Cabletron FN-100 series of switches are available in two models. The FN-

100-8TX is an 8-port hub (\$16,800 list) and the FN-100-16TX is a 16-port hub (\$24,115 list). Each port is capable of operating at either 10 Mbps or 100 Mbps, making for easy upgrades. Cabletron's Spectrum management applications allow you to manage the hubs from a centrally located station.

Similar to the FN-100, the Bay Networks' 28115 LattisSwitch 16-UTP port switching hub (\$16,500) supports both 10 Mbps and 100 Mbps at each port. Two optional high-speed transceivers with 100Base-TX (\$795) and 100Base-FX (\$995) are available. Seven LattisSwitches can be linked together for a total of 112 managed ports and 32 VLANs per switch. This equals 64 VLANs for the entire stack. LattisSwitch uses Bay's Optivity network management application.

The Cisco Catalyst 2900 series offers 12 10/100 switched Fast Ethernet TX or FX ports starting at \$15,000. Two additional ports are used for linking to other switches. CiscoView, Cisco's management package, is used to configure and manage the Catalyst 2900. Additionally, the Catalyst 2900 comes with RMON support built in. □

MULTIPLE ACCESS By Robert P. Lipschutz

Hop on the New Network



Web this, Web that. Every company we talk with says it has an Internet or intranet product, even if it doesn't. It's a whole new networking world out there. NetWare and its IPX/SPX protocol must share networking bandwidth with Windows NT, Web products, and TCP/IP. Besides this onslaught, you've got

new networking technologies to think about. Here's a quick take on some products that can help you in your migration to TCP/IP intranets running over switched Ethernet and Fast Ethernet.

First, the right operating systems can make the change go more easily. Windows 95, OS/2 Warp Connect, and Windows NT each can load multiple networking clients, and each has a TCP/IP stack built in. In addition, each has a broad range of drivers for the fast networking adapters. On your server, Windows NT and all the Unix platforms make "going TCP/IP" easier by providing the protocol stack and applications such as FTP server, HTTP server, DNS, NNTP, SMTP, and telnet. Novell's NetWare IP will boost its TCP/IP connectivity as well. But you should think about trying SunSoft's Solaris or SGI's IRIX for some of these TCP/IP applications.

On to your clients. Get around the problem of a TCP/IP ad-

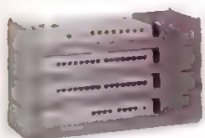
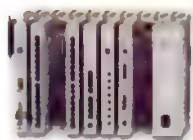
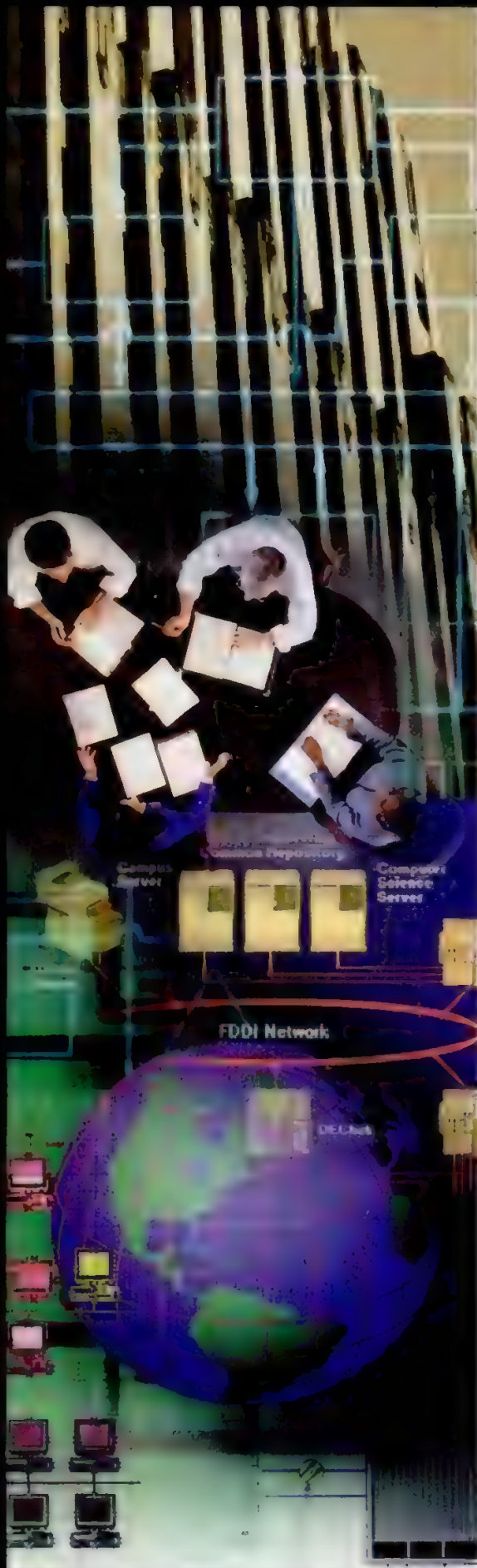
dress at every desktop. Use the Dynamic Host Control Protocol (DHCP) for allocating a central pool of addresses to desktops. Or use an IPX/IP gateway—such as Bay Networks' Instant Internet, Cisco's Internet Junction, or Firefox's Nov*ix for NetWare—and don't touch your clients.

Next, grab some new analysis tools that work with the new networks. All the latest protocol analyzers have Fast Ethernet options, including Wandel & Goltermann's new DA-31, Novell's LANalyzer, and Network General's Sniffer. To manage switched networks, you'll need RMON on your switch. Take a look at Cisco's Catalyst, Fore Systems' ES-38XX, and Madge's SMON.



Buy for the future when you can. Buy Fast Ethernet 10/100 adapters even if you only plan to use the 10-Mbps option for a while. Cogent, Intel, SMC, and 3Com have done very well on our tests. Buy Ethernet switches with high-speed connection options. Buy Web servers, and use them in your own department. Take some of your programming talent, and turn it loose on the new brand of client/server computing using Web browsers, servers, and database backends.

Whatever you do, don't try to limit the creativity of the intranet revolution. Don't try to control your users' communications channels. Just take care of the important data. Let each person load a local Web page, and use an individual e-mail package. You make the decisions on the database connectivity and critical data. Just resolve to find new ways to leverage the TCP/IP applications that have worked so well for the Internet. Don't fight it—you can have all the bandwidth you need.



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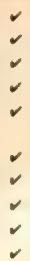
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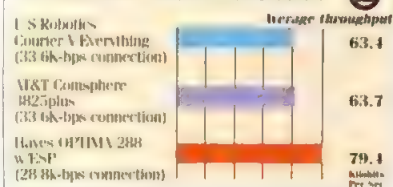
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First Looks

HANDS-ON REVIEWS OF NEW SHIPPING PRODUCTS

WIDE-AREA CONNECTIONS

Hughes Networks on The Final Frontier

By Jeffrey G. Witt

For personal computer users, space is no longer the final frontier. High-speed digital data is now within your orbit by way of the Hughes DirecPC satellite information service, not to be confused with the home entertainment service provided by a sister company of Hughes. Hughes Network has combined satellite and computing technologies to offer Internet connectivity, data transmissions, and real-time audio and video broadcasts.

This system offers high-speed data communications be-

yond 28.8-Kbps modem speed, and it isn't constrained by geographical location. Unlike ISDN, the DirecPC service is available now in all 48 contiguous states. This claim can't be made by such competitors as cable modems and ADSL, both of which hold promise but are still in the definition and testing phase.

End users and corporations alike will be attracted by the anywhere, anytime capabilities of DirecPC service, but the actual deployment may be quite different for the two groups. Small offices and individuals who don't have communica-

tion infrastructures available or in place will look first to DirecPC's Internet application, while the interest of larger organizations will lie in the product's software distribution mechanism or multimedia content. Cost effectiveness can only be measured by comparing the price of DirecPC service with that of similar services in your area or of the service you are using now.

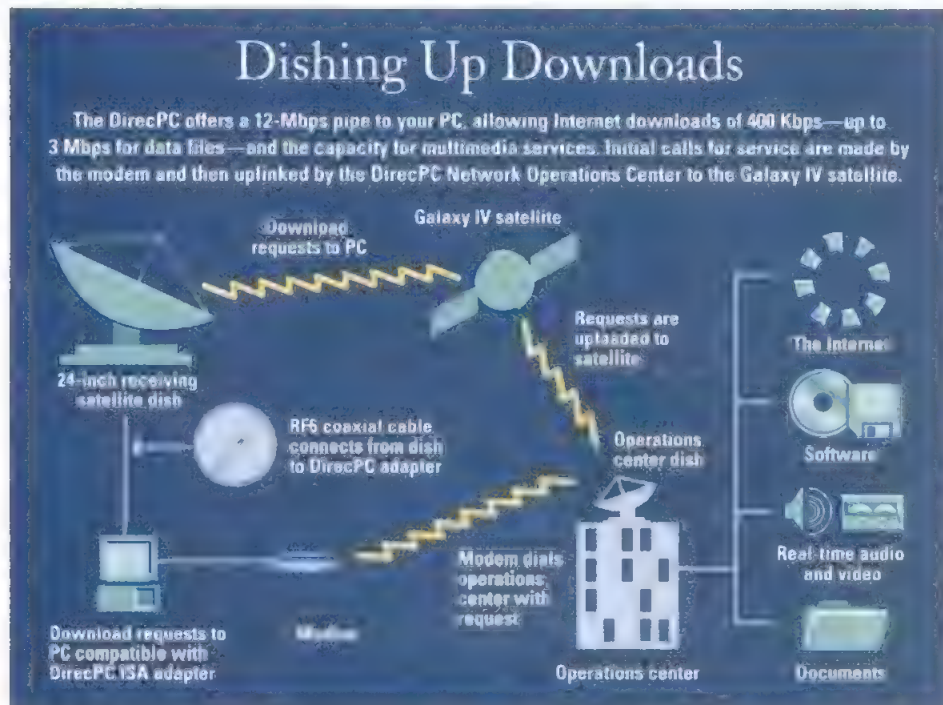
As stated, corporate attention will fall primarily on the distribution of real-time data and multimedia application potential offered by the product. The real-time stock and sports tickers, as well as the CNN Headline News broadcast in Indeo format, give a taste of the versatility and possibilities for corporate content and presentation.



BEAM ME DOWN: DirecPC provides massive download capabilities.

These real-time applications, while fun to have on the desktop, give only a sense of the possible. Like all new technologies, the first generation always tends to be a little rough around the edges. We were able to use them under both Windows 3.11 and Windows 95, but their memory requirements didn't allow simultaneous use on our 16MB machine. The interfaces for the stock and sports tickers are sparse, and the CNN broadcast quality, will remind you of an ISDN video-conference.

Hughes, however, doesn't intend to be the sole application or content provider. IBM already has enlisted the technology to distribute its software to dispersed sites and potential retail locations. Optional licensing packages are available for posting third-party content, including service for high-quality MPEG-1 formats that can be used for distance learning or for broadcasting corporate training videos. Any regularly transmitted information in any one of a variety of formats is a candidate for the DirecPC, with potential cost savings based on fixed volume rates for posting content. In addition, Hughes



First Looks

DirePC Access Kit

has a DES encryption scheme that provides security for any transmitted data.

As for individual users, the Web surfing that DirePC offers will draw interest initially because of the ever-growing popularity of the Internet. This is DirePC's most compelling application. Touring Web sites is quick with DirePC's included Turbo Internet software and any browser.

Using Netscape Navigator, we moved from link to link quickly, because modem requests are small and graphically intense Web pages are downloaded at a fast clip. In anecdotal testing, we found ISDN cruising somewhat quicker. But when it came down to actually downloading large files from the Web, ISDN could not compare with DirePC's ability to handle large documents, video, and audio clips. (Hughes claims you can download a 400-page document in one minute.)

Users can use their own Internet Service Provider (ISP), as long as the ISP provides a SLIP/PPP connection. Hughes can act as your ISP, but the cost is relatively high—\$2.95 per minute as compared with the average \$2.95 per hour that most ISPs charge. The basic package's monthly fee covers up to 30MB of downloaded data per month. Additional services are provided on a pay-as-you-go basis.

Larger companies will find the DirePC's Internet access capabilities less compelling because of its lack of robust networking options. The cable from the satellite dish can be split and additional adapters purchased, but the additional cost and configuration may prove prohibitive. Hughes has plans to deliver products to leverage current network installations in the future.

As for performance, the DirePC offers a 12-Mbps pipe to your PC, allowing Internet downloads of 400 Kbps—up

to 3 Mbps for data files—and the capacity for multimedia services. DirePC's high performance is a one-way street, however, because initial calls for service are made by a traditional analog modem. The requests sent by the modem are uplinked by the DirePC Network Operations Center (NOC) to the Galaxy IV, a geostationary satellite orbiting 22,000 miles above the surface of the Earth.

The DirePC Access Kit

(DAK), Model 40 costs \$695 and consists of an ISA adapter card, software, and a 24-inch elliptical dish with mounting hardware. Bundled with the DAK are a number of services maintained for a \$15.95 monthly fee. These include the Turbo Internet software, Starlight Network's CNN Headline News, DATA Broadcasting's financial ticker, and SportsTicker, as well as access to Package Explorer, an electronic catalog of free and for-sale services.

Installation can be done by the sophisticated user, or by Hughes for an additional fee of \$450. To access the system, you'll need a DOS/Windows PC with at least a 486/66 processor, 8 MB of RAM, 500 MB of disk space, and a modem with an analog phone line.

DirePC Access Kit, Model 40. List price: \$695. Hughes Network Systems, Germantown, MD; 800-347-3272; <http://www.hns.com>. Circle 951 on reader service card.

INTRANET SOFTWARE

More Notes for the Web

By Tony Pompili

The most recent effort by Lotus Development Corp. to make Notes, its popular groupware and communications software, the application development platform of choice for the Internet has taken the form of InterNotes Web Publisher 4.0. Though not a revolutionary upgrade, this version's linked graphics and its ability to run on AIX, OS/2, Sun Solaris, Windows 95, and Windows NT give Notes sites an incremental upgrade to the previous version and extend the product to sites running on niche platforms.

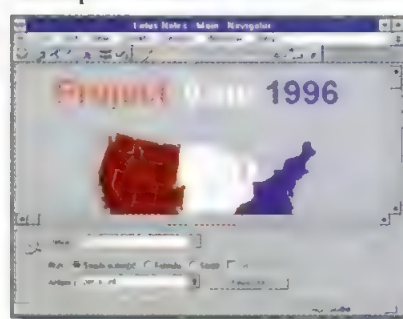
Notes sites looking to improve the appearance of their Web Publisher sites will appreciate this latest version. It is, however, more useful as an add-on for companies already invested in Notes rather than as an inducement to purchase Notes and use it as a Web application development tool.

Web Publisher also has a couple of drawbacks. Like the previous version, it generates HTML pages but doesn't broadcast them. This means you still need a Web server. But Web Publisher will operate with any Web server that works with Common Gateway Interface (CGI) programs.

Another shortcoming is that Web Publisher, the Notes server, and the Web server all have

to reside on a single machine. Because the Notes server is demanding in terms of RAM, processing clock cycles, and hard disk utilization, you'll probably want a beefy box, especially if you're planning to connect users.

We tested Web Publisher on Windows NT Server 3.51 with Service Pack 4 using Windows 95 clients. And we used Netscape's Navigator 2.0 and Netscape Commerce server.



YOU HAVE A CHOICE: InterNotes is available for all the popular OSs.

The primary function of Web Publisher 4.0 is to convert Notes databases, views, and documents into HTML pages. Web Publisher performs two server tasks that create a bi-directional gateway between Notes and Web servers. It checks a list of to-be-published Notes databases at user-defined intervals, automatically converts any new views or documents into HTML pages, and

places them on the Web server. It then converts text and Notes DocLinks to HTML rich text and links the them automatically. You can also design applications that use HTML forms to collect information from Web browser users and add the results to a Notes database.

But one of Web Publisher's best attributes is that it is bundled free with any single or multiprocessor Notes Release 4.x server. Notes 4.1, which wasn't available at press time, will ship with Web Publisher right on the CD. Owners of previous versions of Notes can download

Publisher 4.0 from Lotus's Web site.

The price tag is fitting because this newest version is lean on added functionality and documentation is neither stellar nor available in a hard copy. The product does, however, bring some of the bells and whistles of Notes 4.0 to the Internet and the intranet

side of the browser. Greater symbiosis with Notes Navigators allows Web Publisher to extend a tiny bit of the graphical Navigators of Notes 4.0 into the world of the Web.

Introduced in Notes 4.0, Navigators let you build database and application interfaces with buttons and linked graphics and icons, making it easier to move about a Notes data-

Continues on page NE26



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NETWORK OPERATING SYSTEMS

Novell SMP: A Step Slow?

By Steve Buehler

In our recent *PC Magazine* roundup of network operating systems (NOSs), "The NOS Evolved" (May 28, 1996), we covered many aspects of NOSs. One aspect that we didn't focus on, however, was symmetric multiprocessing (SMP). Now we can. We have Novell's NetWare 4.1 SMP in house, and at first look Novell seems to have taken only a small step forward in technology.

But Novell is aggressively rolling out NetWare 4.1 SMP. This NOS requires certification of hardware compatibility that is

available only through hardware manufacturers, of which there's a long list. Industry giants ALR, Compaq, HP, NetFrame, Tricord, and many others have NetWare 4.1 SMP available today. Potential buyers should look carefully, though, because NetWare 4.1 SMP will earn its keep only in selected applications.

Since NetWare was originally developed for file and print, we didn't expect to see huge performance gains in that area from SMP-enabled NetWare. *PC Week* reported on an in-depth performance test of Novell SMP in their April 1, 1996, issue, and the results confirmed what we expected to see. Our Labs testing showed that if you use your Novell NetWare server for file and print, additional CPUs and the SMP NLMs will not gain anything for you.

The additional

Finally! Novell's entry into the SMP market is out. Although our testing shows that extra CPUs don't make much difference in NetWare's traditional file and print territory, you've got to be able to run on multiprocessor systems in this exploding era of applications servers. There, the SMP version of NetWare does affect performance and could help Novell hold onto some of its installed base.

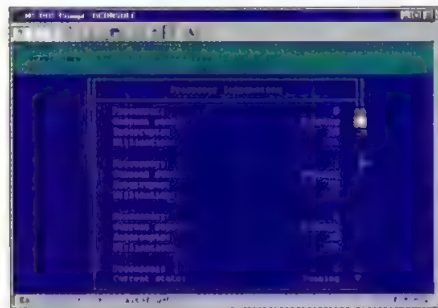


Frank Derfler



Gail Shaffer

Yes, Frank, but you need a separate package, and retrofitting an older NOS may not yield as sleek a product as Windows NT, engineered from the start to handle SMP. Early adopters of SMP had only Windows NT. Administrators may be looking more for the best integration between Windows NT app servers and NetWare networks than anything else.



INCREASING THE TEMPO: NetWare 4.1 SMP increases application server throughput.

processors slow down your total throughput, especially when you have fewer than 20 clients attached to the network. NetBench benchmark tests indicated that a single processor NetWare peaked at about 30 Mbps with 16 clients; the SMP-enabled version topped out at about 22 Mbps with 20 clients.

In application server testing, NetWare showed a nonlinear increase in throughput as CPUs were added. Four processors provided 2.8 times the through-

put of a single processor.

Successfully integrating SMP into a network environment will take some work. Increased throughput tends to highlight other bottlenecks in the server; NetWare's SMOP capabilities can outrun most server disk hardware use today.

NetWare 4.1 SMP. List price: Varies according to vendor. Novell Inc., Provo, UT; 800-638-9273, 801-861-7000; <http://netware.novell.com>. Circle 953 on reader service card.

InterNotes

Continued from page NE24

base. For example, you can create a graphic that, when clicked on, opens a view. And Web Publisher lets you convert some Navigator elements to Web Publisher pages.

You can convert a Graphic Background, which is basically wallpaper that is segmented into hotspots. Each hotspot can have its own link to a document or view. Some of the other graphical elements, such as buttons and graphical buttons, are not yet supported under Web Publisher.

Notes includes some commands such as URLOpen that allow you to dovetail Notes database development with Web Publisher applications.

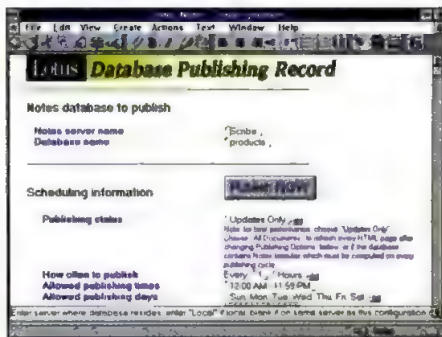
Other commands—creating full-text search fields, for instance—use the Description field, which was formerly reserved in Notes applications for help. This is still a bit of a kludge because it means that you will probably have to make separate forms and views for Notes users and Web browser users.

Just as in Version 2.1, you can customize which databases are published and how often with Web Publisher Configuration database, another Notes Release 4 database. You can also specify where your home page is and define basic HTML tags and table preferences to customize your HTML pages.

Because the product is now distributed on the Internet, no hard copy documentation is available. Instead Lotus supplies a Notes database and a Toolkit that has some useful application hints. Strangely enough, the Toolkit applies only to Web Publisher 2.1, not this version.

Other documentation holes include a lack of sample databases. The single database supplied doesn't even include an example of Navigator, or image maps as they're called on the Web side of Web Publisher. The Lotus site itself is sparse. And this is one of

those products that could really benefit from good starter applications or templates. **InterNotes Web Publisher 4.0.** List price: Free with Notes 4.1 or downloadable from the Web. Lotus Development Corp., Cambridge, MA; 800-553-4270, 617-577-8500; <http://www.lotus.com>. Circle 952 on reader service card.



POSTING NOTES: Web Publisher 4.0 converts Notes databases and views into Web pages.

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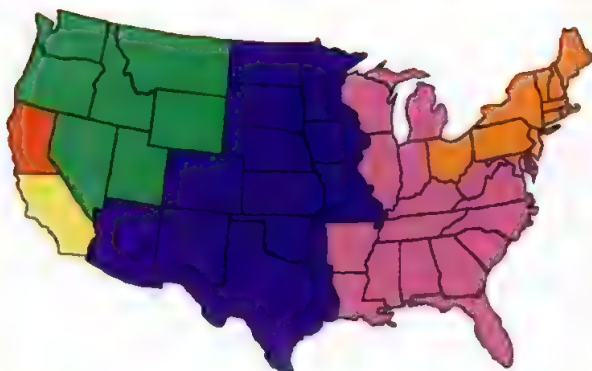
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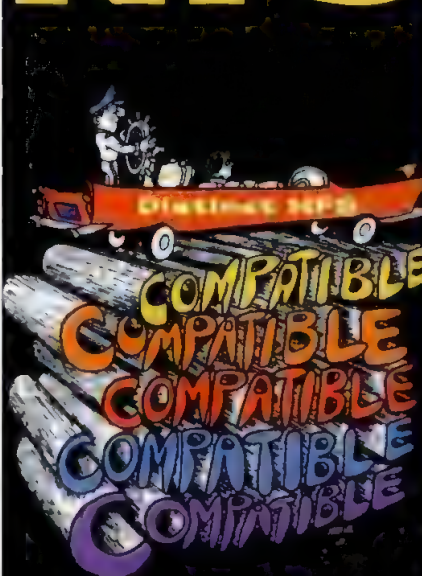
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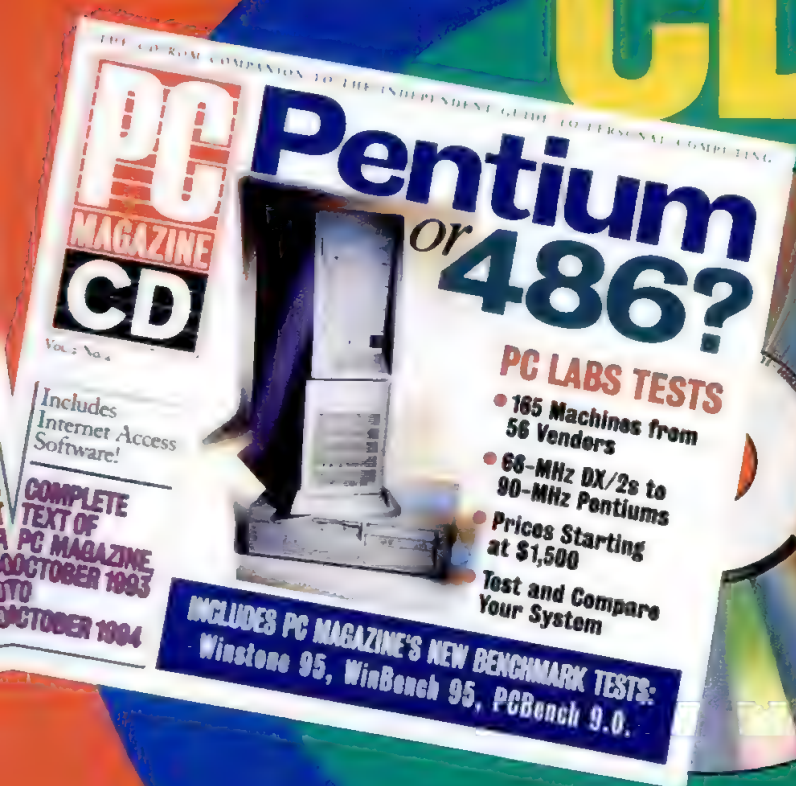
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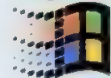
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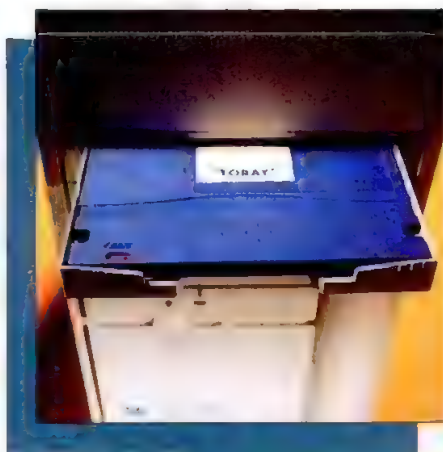
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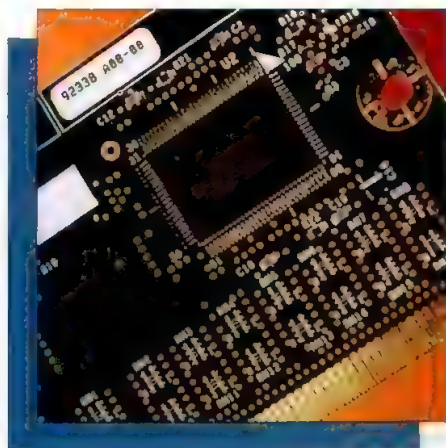
Pentium Classic: Still the One



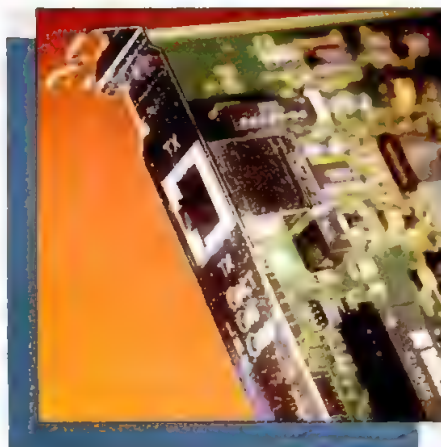
Toray's PhaseWriter PD/CD drive does double duty: Not only does it provide 650MB of storage space using optical cartridges, but it also acts as a quad-speed CD-ROM drive.



Burst EDO DRAM (BEDO), another new type of memory, was found in two PCs. BEDO boosts performance over FPM DRAM because of its internal address counter, which allows data to be sent in bursts.

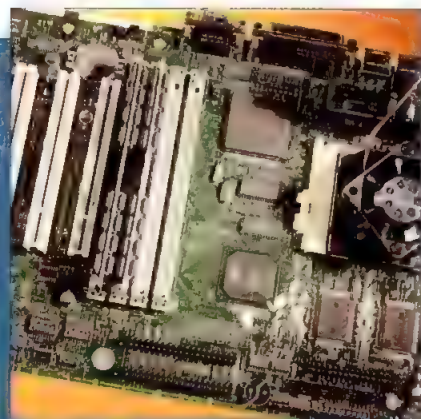


Synchronous DRAM (SDRAM) made its debut in this roundup, both on graphics cards and as main memory. SDRAM includes an on-chip burst counter that can be used to increment column addresses for speedy burst accesses.



3Com's Fast EtherLink 10/100-Mbps PCI Fast Ethernet adapter provides a link to today's 10-Mbps Ethernet networks as well as tomorrow's 100-Mbps LAN connections.

With enough power to handle today's applications, the Pentium Classic still reigns as the right choice for the most users. PC Labs tests 101 Pentium-class machines—ranging from 120 to 166 MHz—using both 16-bit applications and the new 32-bit ZD benchmark program, Winstone 32.



Intel's ATX motherboard and Triton II chip set represent the wave of the future. While the ATX board is less expensive to manufacture than previous board styles and offers a cleaner design, the Triton II chip set supports up-and-coming technologies such as USB.



Motorola's BitSurf ISDN modem is perfect for speedy Internet connections—if you have an ISDN phone line. It even has its own UPS, so you can still use the phone line if the power goes out.



Omega's Jaz, a removable cartridge drive system, provides 1GB of additional storage capacity—enough to back up many of today's hard disks.

By Robert S. Anthony

Even though Intel's Pentium processor has had some competition along the way, it still reigns as the people's choice for mainstream desktop PCs. Why? Because the Pentium still has enough data-crunching muscle to do what most of us need to do. Even though much of today's Windows 95 software is chock-full of high-resolution color graphics, full-motion video data, and other processor-taxing functions, today's Pentium-powered PCs are still able to handle the workload with power to spare.

PHOTOGRAPHS BY TUDOR O'CONNOR

IN THIS REVIEW

ACMA Computers Inc.	108
All Computer Warehouse	126
AMAX Engineering Corp.	126
AST Computer	135
Austin Direct.....	135
Blue Star Marketing Inc.	136
CompuTrend Systems Inc.	136
Comtrade.....	137
CSS Laboratories Inc.	138
Data Storage Marketing Inc.	138
Dell Computer Corp.	139
Diamond Technologies Inc.	140
Digital Equipment Corp.	140
DirectWave Inc.	141
DTK Computer Inc.	144
EPS Technologies Inc.	144
Everex Systems Inc.	145
Gateway 2000 Inc.	146
GST/Micro City Inc.	147
HD Computer	147
Hertz Computer Corp.	148
Hewlett-Packard Co.	148
HiQuality Computer Systems	149
IBM Personal Computer Co.	150
Maximus Computers Inc.	150
Mega Computer Systems	150
Memorex Telex Corp.	152
Micro Express	152
Micron Electronics Inc.	152
MidWest Micro	154
National Microcomputers Inc.	154
NEC Technologies Inc.	156
NETIS Technologies Inc.	156
Polywell Computers Inc.	156
Quantex Microsystems Inc.	158
Reason Technology Inc.	158
Robotech Inc.	158
Royal Computer Inc.	163
S.A.G. Electronics	163
Summit Micro Design.....	163
Swan Technologies Corp.	164
Sys Technology Inc.	164
Tagram System Corp.	164
Tangent Computer Inc.	166
Tatung Co. of America.....	166
Unisys Corp.	166
Unitek Technology Inc.	170
USA Flex	170
US Computer Direct.....	170
Vektron	171
Editors' Choice	103
32-Bit Performance:	
Pentium vs. Pentium Pro	104
Performance Tests	116
Summary of Features	135

STILL THE PEOPLE'S CHOICE

While the Pentium trails the Pentium Pro in terms of pure processing power, it remains the most popular PC processor for mainstream Windows 3.x and Windows 95 applications by a wide margin. Part of the Pentium's success lies not in the chip itself, but in the components that support it, such as PCI and graphics chip sets. Thanks to motherboard improvements and better-performing peripherals, PC vendors consistently manage to tweak more performance out of the now-mature Pentium architecture. Look at some recent 166-MHz Pentium PC reviews, in which performance has improved over time.

We first tested Pentium/166 PCs in our First Looks section (January 23, 1996). The fastest of six systems was a Dell Dimension XPS P166c, which posted a Winstone 96 score of 74.9. The best Winstone 96 score in this roundup is 8 percent higher: an 80.9 that was posted by Reason Technology's Reason Square 5 DP-TR2/HX.

Another reason for the Pentium's mainstream dominance is that the case for the Pentium Pro is not yet overwhelming. Given the continued usage of Windows 3.x in business environments and Windows 95's stronghold in the home and small business sectors—both OSs under which Pentium Pro gives little or no performance boost—Pentium Pro does not yet provide an acceptable balance between price and performance for the mainstream user. This may change next year, however, when Intel reportedly will release a new, cheaper-to-manufacture version of the Pentium Pro (code-named Klamath), sans on-board L2 cache, aimed at the 32-bit corporate desktop. The intro-

duction of Version 4 of the Windows NT workstation later this year will also spur widespread Pentium Pro adoption.

CYRIX: A TRUE CONTENDER

Cyrix Corp. has succeeded in building an attractive Pentium alternative: the Cyrix 6x86 processor. In fact, the three Cyrix-based machines here performed so well that one of them, Sys Technology's Sys Performance C166T2A+, came within a hair (0.2 points) of posting the top Winstone 96 score in this review.

But while this performance is definitely impressive, it does pose the question, "Where's the plus?" Cyrix dubs this chip the P166+ because it claims that PCs with the chip will outperform comparably

equipped Pentium/166 PCs under Windows 95. This claim is based on the P-Rating Specification (developed by Cyrix and AMD, among others, and based on Winstone 96) as a basis for comparing system performance.

The answer here may lie in the chip set. The Cyrix 6x86 is Pentium pin-com-

patible, and it can use Pentium-compatible PCI chip sets: In fact, all three 6x86 PCs in this roundup use Intel Triton or Triton II chip sets. But Triton and Triton II aren't optimized for the 6x86. They don't support the 6x86's linear burst mode which, if supported, should boost CPU performance by about 3 to 5 percent. Surprisingly, the only units here with chip sets that support the 6x86's linear burst mode are two Pentium PCs (Everex's Tempo Select 166 and 133) that each use VIA's Apollo-VP chip set.

The Cyrix 6x86-powered PCs reviewed here were aggressively priced between \$2,375 and \$2,759. By the time you

RECENT REVIEWS

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May 28, 1996page 100
We look at the state of the micro-processor market and test the first Cyrix 6x86-based PCs.

► PowerHouse

April 23, 1996.....page 299
11 home PCs

► Server Power

March 26, 1996.....page 146
Six Pentium-powered departmental file servers.

Our Contributors: ROBERT S. ANTHONY is a senior writer at *PC Magazine*. CADE METZ is a staff writer at *PC Magazine*. DAVID LIDSKY is a staff editor and RICHARD S. SHIM is an editorial researcher at *PC Magazine*. BRUCE BROWN and ALFRED POOR are contributing editors, and CHARLES LIN is a freelance writer for *PC Magazine*. MARGARET PIEMONTE is a technical analyst for PC Magazine Labs. CAROL VENEZIA was the associate editor in charge of this story, and RICHARD FISCO was the project leader.

read this, Cyrix itself and a handful of other PC vendors will be selling Cyrix-powered PCs. But Intel isn't standing still: It is poised to release a 200-MHz Pentium CPU in the very near future. So who will win this battle of the CPUs? The user, of course.

REVIEW CRITERIA

For this roundup, vendors were invited to submit Pentium-class PCs from each line of business PCs that they sell (typically, value and performance). Within each category, they could submit a *midrange* PC using a 120-MHz or 133-MHz Pentium CPU and a *high-end* machine based on a 150-MHz or 166-MHz Pentium. Companies had the option of sending equivalent Cyrix 6x86-based machines.

These machines are not home PCs but are targeted for mainstream business use. As such, many address issues that are important to the business user, though not necessarily to the home buyer, such as full DMI support, preloaded drivers for popular network operating systems, and extensive security features.

All machines had to be configured with 16MB of RAM, a hard disk with a capacity of at least 1GB, a quad-speed or faster CD-ROM drive, a 16-bit sound board or an integrated sound subsystem, an SVGA graphics card, a 15-inch or larger monitor, a keyboard and a mouse. This filter netted us 101 PCs from 50 vendors, 44 in the midrange class and 57 in the high end.

NEW 32-BIT TEST: WINSTONE 32

This roundup also brings with it the introduction of our new 32-bit benchmark test program, ZD Winstone 32. Exercising a script of eight of today's most popular 32-bit applications, this test program allows us to judge a PC's ability to handle a 32-bit environment. We use this test in this roundup under Windows 95 and will continue to use it in the future under Windows NT Workstation 3.51 as well. Note, however, that Winstone 32 scores *cannot* be compared with Winstone 96 scores because they are built on different applications. (For an explanation of Winstone 32, please refer to the Lab Notes section of this issue.)

In previous testing, we've found that the Pentium is on a par with the Pentium Pro on the performance scale under Windows 95. This is because Windows 95 still

Value:

Dell Dimension XPS P133c

Midrange:

Micron Millennia 133

High-End:

Micron Millennia 166

The three Editors' Choices in this roundup indicate that no matter what your budget, there's a PC to suit your computing needs. Our value choice for those

who want to pay less than \$2,500 is the \$2,379 Dell Dimension XPS P133c. This system is outfitted with everything you need for basic computing tasks, and then some. Its features include a speedy 1GB Quantum Fireball hard disk and a Number Nine Motion 771 graphics adapter, which together helped it to achieve very competitive benchmark test scores within its 133-MHz CPU class.

Dell also includes a 6X CD-ROM drive and Microsoft Office Professional for Windows 95 with Bookshelf. Add to this a three-year-parts and one-year-labor warranty and you have a great value choice.

Our next two Editors' Choices, the \$3,148 Micron Millennia 133 and the \$3,517 Micron Millennia 166, are built not only for speed but for the future. Both use Intel's new OP5D ATX-form-factor motherboard and Intel's 430HX PCI chip set, which supports dual CPUs and ECC memory.

The Millennia 133 stands out because its performance and features exceed those of the majority of the high-end systems in this roundup. Its components—256K of pipelined-burst

L2 cache, a 1.2GB Quantum Fireball hard disk, and a Number Nine Imagine 128 Series 2 graphics card—worked to produce benchmark test scores that not only led the midrange class but were also on a par with the majority of the high-end entries. To complete this package, Micron adds a 17-inch MAG monitor, a 6X CD-ROM drive, a plug-and-play wavetable audio board, and Advent AV270 speakers.

Like its 133-MHz sibling, the Millennia 166 was a strong performer: Using the same Number Nine graphics card, it garnered the second-highest Graphics WinMark 96 score of this roundup. This machine features many of the same components as the Millennia 133 but ups the ante to include an 8X Hitachi CRD-7930 CD-ROM drive.

We also found two PCs worthy of honorable mention: the \$2,749 Step Premier 133 from Everex and the \$2,414 Gateway P5-133. The Step Premier 133 was a top performer in its CPU class, and it is backed by a five-year warranty. Those who want a solid machine priced below \$2,500 will find the Gateway an excellent choice.

Pentium Pro PCs"). Using Winstone 32, we see that under Windows NT, Pentium Pro-equipped machines best Pentium-based PCs by about 35 percent.

USB: ON THE WAY

In terms of features, the Universal Serial Bus (USB) standard promises to simplify



the maze of connectors on today's PCs. With USB, which operates at a data rate of 12 Mbps, you can connect up to 127 USB-compatible peripherals to one PC. (The *key-board's* connected to the *print-er*, the *print-er's* connected to the *mo-dem*. You get the idea.)

Obviously a single port for all devices would be a godsend for the growing pool of new PC users, from whom concepts such as IRQs and bidirectional printer cables can draw blank stares, or for more skilled users who know what IRQs are and know that they're running out of them. While 22 of the 101 machines in this review came with Intel's Triton II or VIA's Apollo-VP PCI chip sets (currently the only chip sets on the market that support USB), what was missing in all cases was the necessary daughtercard to provide the external USB connector.

Also missing are USB peripherals to connect to such a port, not to mention the necessary drivers to make them work. Obviously vendors aren't going to spend extra money to configure their PCs for peripherals that don't yet exist. USB devices should be readily available later this year, beginning with simple devices like mice and keyboards.

PLAYING WITH FIREWIRE

Another up-and-coming serial bus technology is the IEEE 1394 standard, otherwise known as Firewire. The Firewire standard for serial communication (developed by Apple) allows for the connection of 63 devices on a single bus at speeds ranging from 100 to 400 Mbps.

Firewire won't compete directly with USB. While USB is aimed at today's peripherals, such as keyboards, joysticks,

32-Bit Performance: Pentium vs. Pentium Pro

As we've found in previous testing, the Pentium still beats out the Pentium Pro on our Winstone 96 test under Windows 95, in this case by a margin of up to 13 percent. Using our new 32-bit benchmark program, ZD Winstone 32, the Pentium still performs well under Windows 95 compared with the Pentium Pro, although not quite as fast. (The HP unit's particularly outstanding Winstone 32 score results partly from a very fast hard disk subsystem.) But the tables turn under Windows NT, where the Pentium Pro can fully flex its 32-bit muscle. On our ZD Winstone 32 measure, both Pentium Pro units beat out the Pentium comparison machine by a wide 35 percent margin.

Under Windows 95, we tested all systems at 1,024-by-768 resolution and 256 colors, with 16MB RAM installed. Under Windows NT, we tested all systems at 800-by-600 resolution and 16 million colors, with 32MB RAM installed. All systems had 256K L2 cache installed.

	WINDOWS 95		WINDOWS NT	
	ZD Winstone 96	ZD Winstone 32	ZD Winstone 32	
	Score	Score	Score	
Micron Millennia 166 (Pentium/166)	77.3	94.3	110.0	BETTER
HP Vectra XU 6/150 (Pentium Pro/150)	68.3	107.6	148.7	BETTER
Gateway G6-200 (Pentium Pro/200)	75.6	88.0	148.3	BETTER

and monitors, Firewire is meant for the super-high-throughput needed for video-conferencing, high-speed modem connections, and other sophisticated tasks. Here again, Firewire has not yet resulted in an avalanche of compatible products.

What Firewire and USB have in common is simplification. Keep in mind that 22 of the PCs here were configured so that there was just one IRQ address free for extra devices such as network cards. Firewire and USB have the potential to make IRQ headaches a thing of the past.

THANKS FOR THE MEMORY

Another way to boost Pentium PC performance is to improve upon the memory technology in it. In this review we find three new types of RAM chips, all with

new human-memory-taxing acronyms.

Many of the new memory types are *synchronous*—meaning that the timing of these chip sets is tied directly to the PC's system clock. The idea is to *synchronize* memory tasks and eliminate wait states, thus enhancing performance.

Two strong performers on our Graphics WinMark 96 tests, AST Computer's Bravo MS 5166 and Royal Computer's Ultra Media Pro, used new types of synchronous memory in their graphics subsystems. The AST unit had an integrated ATI 264 VT PCI graphics chip set with 2MB of SGRAM (synchronous graphics RAM). Its score beat out that of other PCs that used PCI graphics boards with 4MB of VRAM. The Royal unit used an ATI Video Xpression graphics adapter that came with 2MB

PENTIUM PCs

How to Read the Service & Reliability Boxes

Ratings are included for vendors that received at least 50 responses on our latest Service & Reliability poll of 17,000 subscribers. These results reflect readers' experience with desktop PCs from a given vendor. For details, see our July 1995 issue.

The **reliability** rating is a measure of respondents' satisfaction with the reliability of the vendor's machines in use over the past two years.

SERVICE & RELIABILITY

Company name

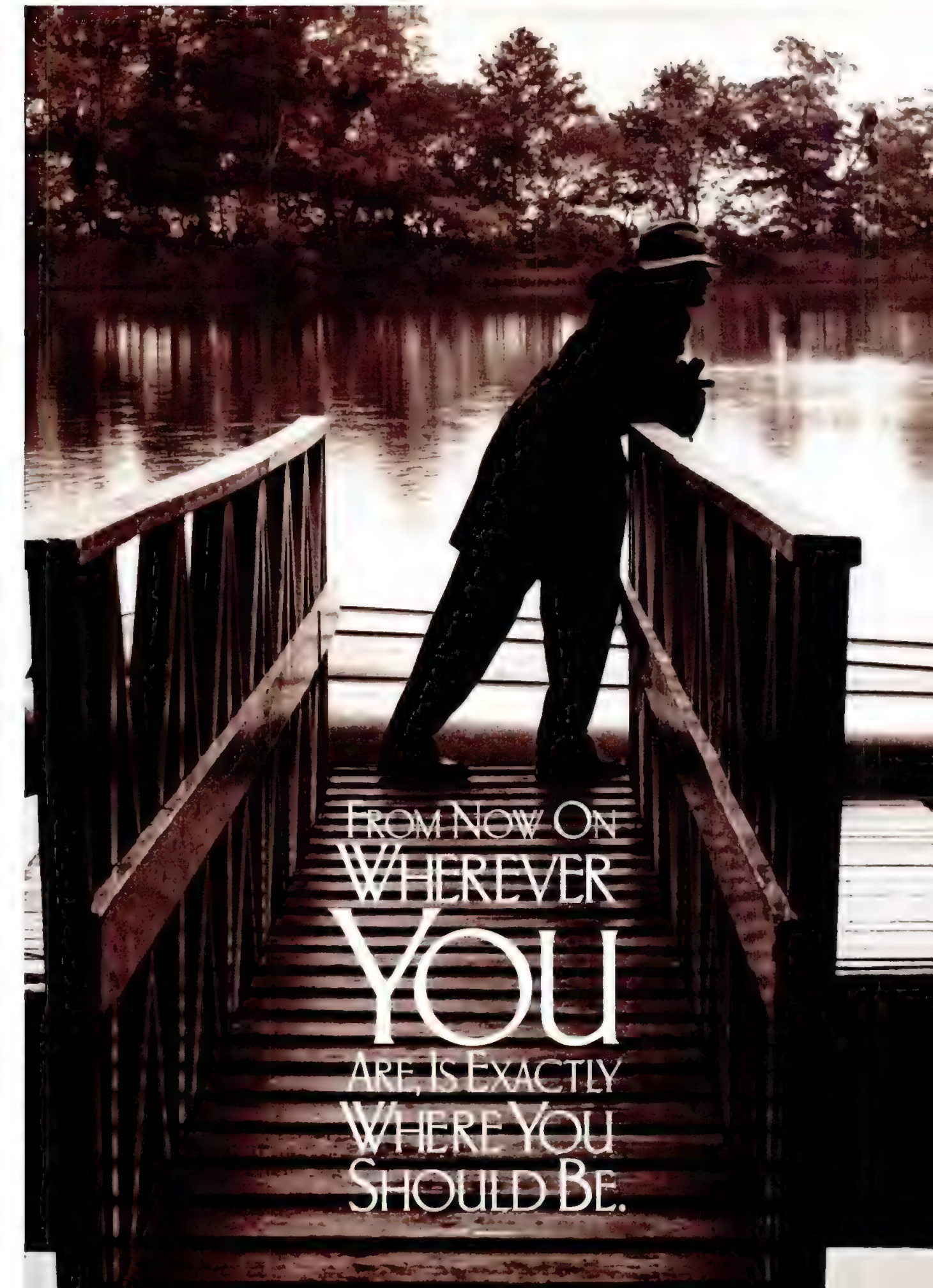
Reliability	Better than average
Repair	Average
Technical support	Average
Percent needing repair	Worse than average

The **repair** rating is a measure of respondents' satisfaction with the repair service provided by the

vendor for machines in use over the past two years.

The **technical support** rating is a measure of respondents' satisfaction with the vendor's support for machines in use over the past two years.

The **percent needing repair** rating is a measure of the proportion of machines that the respondents indicated needed repair during the first year of use.

A man in a dark trench coat and a fedora-style hat stands on a wooden walkway with railings, leaning forward and looking out over a calm body of water. The background is filled with dense trees, and the scene is bathed in a warm, golden light, suggesting sunrise or sunset. The overall mood is contemplative and serene.

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HIGHLIGHTS

Pentium PCs

Whereas the Pentium Pro is poised to claim the mainstream business market once full 32-bit OSs become commonplace, the Pentium Classic is still ensconced as the best-selling processor for today's demanding applications. Aided by an increasingly adept cast of supporting hardware players—such as new chip sets and memory standards—the Pentium's performance continues to improve as its price declines.

New memory technologies boost the Pentium's performance. We saw synchronous graphics RAM

(SGRAM), synchronous DRAM (SDRAM) and Burst EDO DRAM (BEDO) for the first time in desktops.

Cyrix's 6x86 chip has mounted a legitimate challenge to the Pentium's dominance. Three machines in our roundup offer the P166+ version of the chip, which actually performs as well as—and in some cases better than—a Pentium/166.

The Universal Serial Bus (USB), which can connect several peripherals to your PC via a single connector, was supported by several machines, but none had an

actual USB port. Expect to see USB ports when USB-compliant peripherals become more readily available. Of the tested systems, 22 had only one IRQ address available for the attachment of additional devices.

The DDC1 (Display Data Channel) standard allowed 16 systems to send their monitor configuration data to the host PC. Six of these monitors also support DDC2, which allows bidirectional communications so that the host PC can seamlessly adjust the monitor's configuration. Monitors that support either standard do not require additional drivers under Windows 95.

of SDRAM (synchronous DRAM).

While about 95 percent of the systems in this roundup use EDO DRAM for main memory, the two Everex Tempo units (the Select 133 and the Select 166) used BEDO (burst extended data out) DRAM. This type of DRAM can deliver large streams of data in bursts.

SDRAM (synchronous DRAM) is another technology that may soon make it into high-end PCs. Right now it's more expensive than BEDO DRAM, but it can handle faster clock speeds. This type of RAM is installed in the Dell Dimension XPS P166s.

KNOCKOUT POWER PACKAGES

The \$5,405 Millennia Plus, a 166-MHz Pentium-based entry from Micron Electronics, offers lots of dazzling features. The Millennia Plus comes with a Motorola BitSurf ISDN modem, a 3Com 10/100-Mbps Fast Ethernet card, and a 1GB Iomega Jaz drive. Few offices and fewer homes are wired today to take advantage of either connection, but both of these technologies represent the future.

The Millennia Plus also uses Intel's new ATX-style motherboard. This board is about the same size as the Baby-AT-style boards that are widely used now, but its layout makes much more efficient use of space. Unlike many Baby-AT boards, in which the CPU socket sits in front of the expansion slots (blocking them, in many cases), the ATX board is laid out in such a way as to allow even full-size PCI boards to be used. It is also a four-layer design, which is less expensive to build than five- and six-layer boards.

TALKING MONITORS

Since its introduction last August, Windows 95 has supported the VESA DDC1 (Display Data Channel) standard, which provides a unidirectional channel that lets the monitor transmit its configuration information and capabilities to the host PC. The DDC2 standard is bidirectional, so the host PC can adjust the monitor as well.

Until recently, very few monitors supported either standard, but this review includes ten systems with DDC1-compliant monitors and six more systems that support DDC2. A key benefit of using either type of monitor with Windows 95 is that each can be set up without the need for additional graphics card drivers.

CHAMPION CHIP

Future OSs may eventually send the Pentium into retirement, but for now you can still combine today's 120-MHz to 166-MHz Pentium CPUs with today's new PCI and memory technologies for a machine with plenty of muscle for the near future. If you're in the market for a new Pentium-powered PC, the reviews that follow should help you with your buying decision.

ACMA Computers Inc.

sPower 133, zPower 133, zPower 166

Direct vendor ACMA Computers targets two audiences with its PC lines: The zPower line is aimed at high-end corporate users, and the sPower is intended for entry-level corporate buyers. Both the \$3,199 zPower 133 and the \$3,999 zPower 166

(marketed specifically to graphic designers and engineers) were competent performers in their respective CPU classes. But both fell short on our Graphics WinMark 96 tests. The \$2,699 sPower 133 posted below-average scores on nearly all tests. ACMA also markets the mPower 486 line to government agencies and the zPower Pro line of Pentium Pro workstations.



ACMA zPower 166

The zPower PCs all have high-speed components, including 512K pipelined-burst L2 cache; the sPower series comes with 256K of slower, asynchronous cache. The zPower units also have better monitors: MAG InnoVision units (15-inch and 17-inch on the

zPower 133 and zPower 166, respectively). The sPower 133 bundles a 15-inch Princeton monitor. Each unit features Altec Lansing ACS5 speakers, Sound Blaster-based audio, a PC Card drive (one Type II slot and one Type III), and a 28.8/14.4-Kbps data/fax modem.

The sPower 133's asynchronous cache contributed to below-average CPUmark scores. Most of the sPower 133's other test results were below average as well, but its 1.2GB Quantum Fireball 1280A hard disk helped it to an average Disk WinMark 96 score. The zPower units were mostly average performers but posted above-average scores on the CD-ROM WinMark 96 tests. Despite the zPowers' inclusion of S3 Vision

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January 9, 1996
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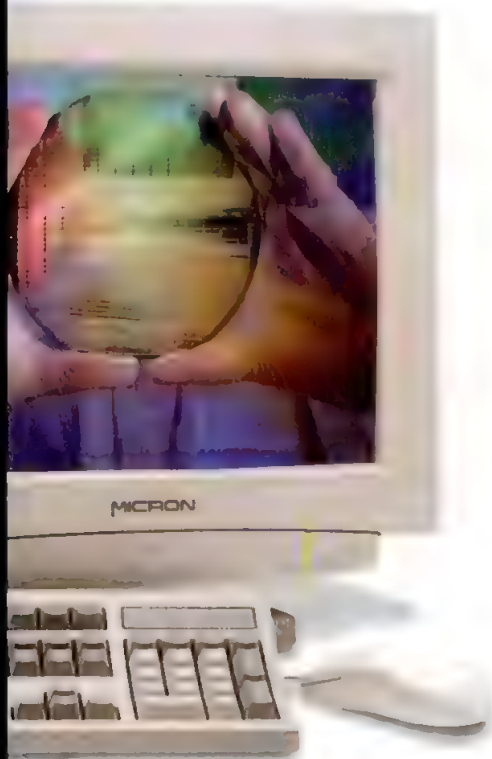
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Satisfaction with Reliability," "Repair Experience," "Technical Support" and "Future Likelihood of Buying Again."



May 30, 1995
MILLENNIA P120

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—*PC Magazine*, April 25, 1995



December 1995
MILLENNIA P133

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—*PC Computing*, December 1995

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- PCI 64-bit video, MPEG, 2MB EDO
- Full-size tower with 10 drive bays
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows NT Workstation 3.51 CD
- 5-year/3-year Micron Power warranty*

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• Microsoft Office Pro 95 & Bookshelf 95 CDs

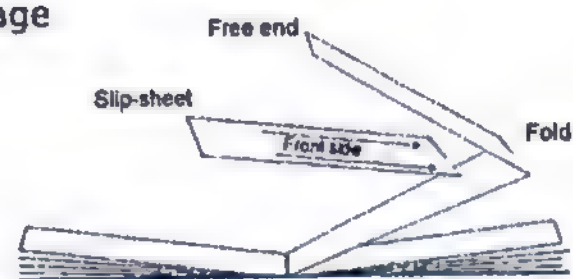
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POWERSTATION LX P100

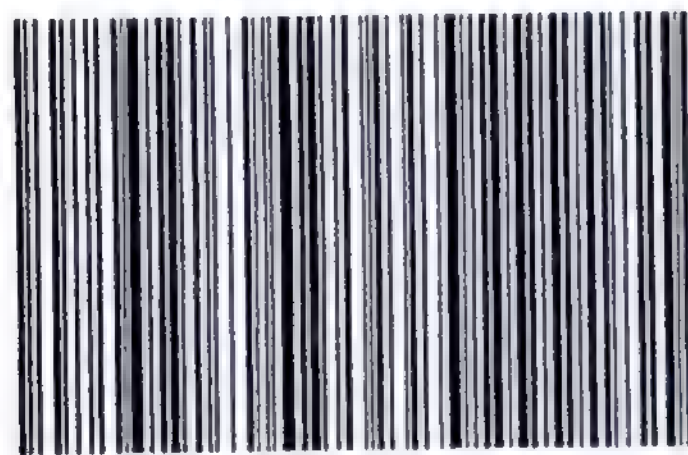
- Intel 100MHz Pentium processor
- 8MB EDO RAM • 1.0GB EIDE hard drive
- 3.5" floppy drive, flash BIOS
- PCI 64-bit graphics accelerator (1MB)
- 15" Micron 15FGx, .28dp (13.7" display)
- Tool-free mini-tower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows 95 & MS Plus!
- Microsoft Works 95
- 5-year/3-year Micron Power warranty*

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 1. Front side touching the free page
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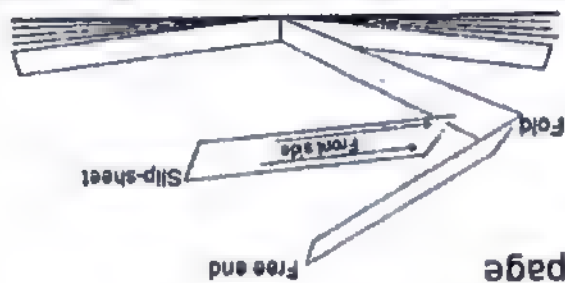
Foldout slip-sheet



Inverted Foldout slip-sheet

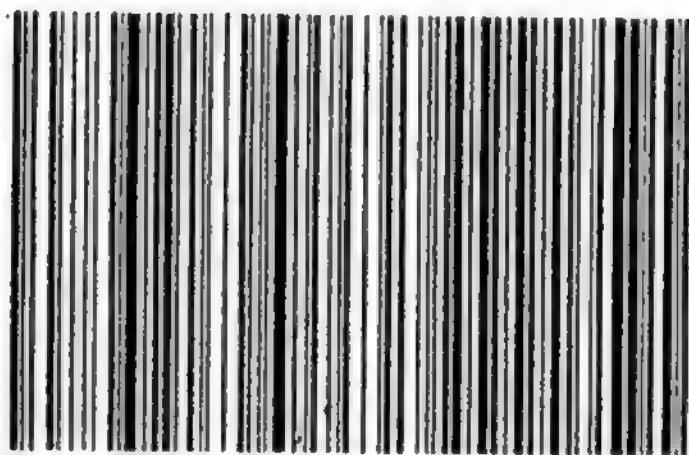
Folded edge of the page

1. Open the foldout page
2. Insert this sheet with
 1. Front side touching the free page
 2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



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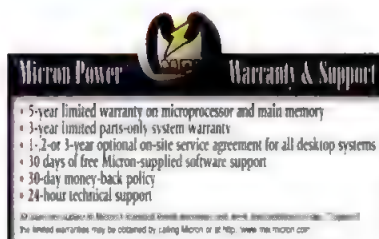
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- **Microsoft Home Pak includes:** Works 4.0 for Windows 95; Publisher Deluxe for Windows 95; Encarta 96; Encarta 96 World Atlas; Music Central 96; Wine Guide; Arcade 1.0; Scenes—Sports Extremes Collection; Cinemania 96; Julia Child Home Cooking; Best of Windows Entertainment Pack; CD Sampler (includes Fury³ game demo)
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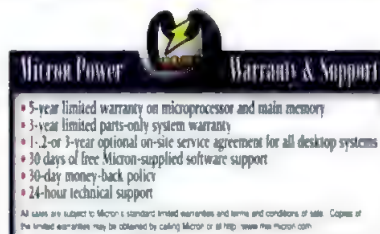
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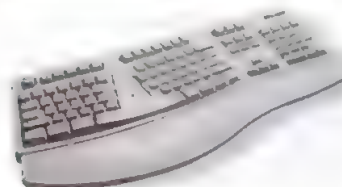
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BENCHMARK TESTS

Pentium PCs



Performance is the name of the game for these Pentium PCs, as new technologies and chip sets—including burst EDO and synchronous DRAM and Intel's new Triton II PCI chip set—boost test scores to new heights under both 16- and 32-bit apps.

What the Numbers Mean

ZD Winstone 96 and ZD Winstone 32 Getting the most out of each subsystem is the key to top PC performance. Large amounts of L2 cache, advanced forms of DRAM, SCSI or top-speed EIDE hard disks, and pixel-pumping 64- or 128-bit graphics engines result in barn-burning PCs. The strongest performers on our ZD Winstone 96 test followed these precepts, and it paid off.

We tested three Cyrix 6x86 P166+-based machines in this roundup. As in our previous look at 6x86 PCs ("Beyond the Pentium," May 28, 1996), all of the Cyrix-based systems posted Winstone 96 scores that

▲ Higher scores represent better performance.
▼ Lower scores represent better performance
Bold type denotes first place.

	ZD WINSTONE 96 Score	ZD WINSTONE 32 Score	ZD GRAPHICS WINMARK 96 Millions of pixels per second	ZD DISK WINMARK 96 Score	ZD CPUMARK ₉₆ Score
MIDRANGE MACHINES (PENTIUM/120 AND PENTIUM/133)					
ACMA ePower 133 (P/133)	58.3	68.1	19.3	1,010	218
ACMA zPower 133 (P/133)	62.8	80.2	21.3	1,110	279
AMAX Powerstation 133F (P/133)	72.5	94.3	29.1	1,230	282
Austin PowerPlus 133 (P/133)	58.5	69.6	21.2	670	272
Blue Star Eclipse E-133 (P/133)	60.2	73.3	24.2	956	246
CompuTrend Premio Triton P133 (P/133)	65.0	81.6	28.0	1,120	265
Comtrade Hyperspeed Multimedia (P/133)	69.2	86.2	26.1	1,150	271
CSS Preferred MT 5/133 (P/133)	71.4	87.7	29.3	1,130	274
Data Storage DataStor P5-133 (P/133)	58.1	77.1	14.3	998	266
Dell Dimension XPS P133c (P/133)	67.3	85.9	21.4	1,140	266
Dell OptiPlex GXMT 5133 (P/133)	64.6	83.0	20.1	1,040	266
Diamond Office Mate 133 (P/133)	67.7	85.6	21.0	1,040	266
DirectWave Blue Thunder (P/133)	72.3	90.1	29.7	1,150	266
EPS Evolution LP-133 (P/133)	67.9	86.3	21.6	1,130	272
Everex Step Premier 133 (P/133)	73.3	90.3	28.5	1,150	277
Everex Tempo Select 133 (P/133)	72.6	89.7	27.4	1,160	267
Gateway P5-133 (P/133)	71.4	86.0	27.2	1,130	274
GST Apogee P133 (P/133)	70.4	89.9	27.9	1,150	273
HD Victoria P-120 (P/120)	62.7	76.8	19.8	990	238
Hertz Z-Pent P133e (P/133)	65.0	82.9	22.1	1,020	284
HP Vectra XM Series 4 5/120 (P/120)	61.1	79.6	17.2	1,090	239
HP Vectra VL Series 4 5/133 (P/133)	62.7	86.9	18.3	1,140	266
HiQuality HIQ P133 Mars Station (P/133)	70.2	87.6	27.6	1,150	279
IBM PC 360 P133 (P/133)	68.2	86.5	28.5	1,100	266
Maximus Magne Media P133 (P/133)	72.8	90.1	28.7	951	269
Mega Impact 5133PC116D (P/133)	66.6	85.1	23.4	1,000	270
	BETTER ▶	BETTER ▶	BETTER ▶	BETTER ▶	BETTER ▶

N/A—Not applicable. The system did not come with a CD-ROM drive. (1) With an Action, Indeo, 320 x 240, 30-fps, 600-Kbps clip

(2) With an Action, Indeo, 160 x 120, 30-fps, 300-Kbps clip scaled to full screen

were higher than the average for Pentium/166 systems. In our May 28 article, Cyrix machines bested the average Pentium/166 by 8 percent, and that trend continues in this roundup. The Cyrix leader in this roundup, as well as in our May 28 issue, came from Sys Technology; in this roundup, it's the Sys Performance C166T2A+. Now using the new Triton II chip set and 512K of L2 cache, the Sys PC was able to scratch out 1 extra point on our Winstone 96 test over its previous score. The top two Intel Pentium/166-based systems—the Everex Tempo Select 166 and Reason Square 5 DP-TR2/HX—practically tied the Sys PC's Winstone 96 score.

Using the latest technology doesn't always translate into great benchmark test scores, however, as evinced by the ACW P5-166BP. This machine used Diamond's Stealth64 Video VRAM graphics board with Diamond's new GT graphics driver. But the GT driver loads the Diamond control panel applet by default

(which is how the ACW machine arrived for testing); this uses an incredible amount of system resources. (Other systems in this roundup using the Diamond GT driver came without the control panel loaded and were tested as configured.) With the Diamond control panel applet loaded, the ACW machine's Winstone scores suffered tremendously: The unit scored 43.4 on our Winstone 96 tests (72 percent below the P/166 average). But when we removed the control panel and reran Winstone 96, the score jumped to 70.1 (on a par with the P/166 average), an increase of more than 60 percent! (Diamond has said that it is rewriting the driver so that the control panel does not load by default; the new driver should be available by the time you read this.)

In this issue we introduce our new Winstone 32 benchmark test, which runs eight of the most popular 32-bit Windows applications.

continues

ZD CPUMARK ₃₂		ZD CD-ROM WINMARK 96		CD-ROM			HIGH-QUALITY ACTION INDEO ¹		FULL-SCREEN SCALING ²		MEDIUM-QUALITY ACTION CINEPAK ³	
				Sequential 16K Read KBps	Access Time ms	CPU Utilization	Frames Dropped	CPU Utilization	Frames Dropped	CPU Utilization	Frames Dropped	CPU Utilization
Score	Score	▲	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
211	457	612	179	45%	0	79%	0	84%	0	59%		
287	611	919	166	30%	4	51%	3	63%	0	38%		
286	611	909	155	40%	0	56%	0	63%	0	41%		
274	596	919	179	29%	0	55%	4	39%	0	48%		
245	485	894	214	62%	0	70%	67	99%	0	49%		
263	607	919	178	46%	0	62%	330	99%	0	42%		
276	655	1,080	168	71%	0	66%	0	67%	0	43%		
274	636	912	159	53%	0	65%	0	69%	0	45%		
269	374	813	327	63%	62	89%	213	99%	9	68%		
271	621	919	161	29%	0	52%	0	64%	0	39%		
268	408	812	244	35%	0	66%	0	70%	0	51%		
285	614	919	164	46%	0	61%	0	65%	0	41%		
294	609	919	189	48%	0	57%	0	64%	0	42%		
277	658	1,090	266	72%	0	72%	0	70%	0	46%		
284	637	911	167	52%	0	56%	0	62%	0	38%		
297	633	916	164	51%	0	70%	0	93%	0	49%		
271	560	926	229	43%	0	60%	0	68%	0	42%		
280	496	919	204	45%	0	61%	0	64%	0	43%		
241	606	919	166	32%	0	56%	0	68%	0	40%		
285	469	813	194	35%	0	61%	411	98%	0	42%		
243	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
266	447	612	214	43%	11	98%	44	99%	0	73%		
290	602	918	180	46%	0	63%	0	72%	0	46%		
271	590	918	189	30%	0	54%	0	64%	0	40%		
297	609	919	173	46%	0	59%	0	67%	0	43%		
271	635	913	185	53%	0	68%	0	69%	0	45%		

BETTER ►

BETTER ►

x 768)

(3) With an Action, Cinepak, 320 x 240, 30-fps, 300-Kbps clip

BENCHMARK TESTS

continued

Since Winstone 32 runs only 32-bit applications, and Winstone 96 is composed entirely of 16-bit applications, Winstone 32 and Winstone 96 results *cannot* be directly compared.

While the average Winstone 32 scores of the three Cyrix PCs in this roundup still exceeded that of the average Pentium/166, the gap was not as wide as with Winstone 96. The top five Winstone 32 scores came from systems based on the Intel Pentium 166. The Reason Square 5 DP-TR2/HX's combination of 512K L2 cache, a Fast/Wide SCSI-2 hard disk, and a Number Nine Imagine 128 graphics card powered it to first place.

ZD Graphics WinMark 96 In this roundup, the AST Bravo MS 5166, the Polywell PolyStation 166P, and the Royal Ultra Media Pro all used the new ATI 264VT graphics chip set. An improve-

ment over the Mach 64, the 264VT chip adds YUV-to-RGB color-space conversion, x and y scaling, and an integrated 135-MHz DAC. A large part of the performance increase comes from the implementation of synchronous DRAM (SDRAM) and synchronous graphics RAM (SGRAM). The AST, Polywell, and Royal machines were all able to use the extra speed boost provided by different forms of synchronous memory to achieve high Graphics WinMark 96 scores.

The Polywell and Royal PCs both used 15-ns SDRAM. SDRAM operates synchronously, avoiding the extra clock cycles needed for the asynchronous operation of DRAM. Standard DRAM must incorporate wait states (or extra clock cycles) that match the specifications of the DRAM to the speed of the memory bus. The 15-ns SDRAMs used by Polywell and Royal can handle up to a 66-MHz bus without additional wait states. SDRAM includes an on-chip

QUALITY

▲ Higher scores represent better performance.

▼ Lower scores represent better performance.

Bold type denotes first place.

	ZD WINSTONE 96 Score	ZD WINSTONE 32 Score	ZD GRAPHICS WINMARK 96 Millions of pixels per second	ZD DISK WINMARK 98 Score	ZD CPUMARK ₉₉ Score
MIDRANGE MACHINES (PENTIUM/120 AND PENTIUM/133)					
Memorex Telex Colorria (P/133)	53.0	63.2	16.5	818	223
Micron Millennia 133 (P/133)	70.3	88.4	29.7	1,160	277
MidWest Micro P5-133 Office PC (P/133)	65.5	83.7	21.1	1,010	267
NEC PowerMate V133 (P/133)	49.7	84.8	11.7	771	262
NMC Expert Plus 133 (P/133)	83.3	80.8	18.7	1,040	205
Polywell PolyStation 133P (P/133)	67.0	90.5	24.0	1,120	256
Quantex QP5/133 SM-2 (P/133)	66.0	82.3	28.4	1,040	272
Reason Savvy TR/Model 1 (P/120)	42.0	51.5	10.2	753	177
Robotech Cobra XLT/2 P133 (P/133)	67.4	95.4	24.4	1,080	280
Royal Ultra Media Pro (P/133)	70.3	85.8	29.9	1,140	288
Swan PowerHouse Deluxe 133 (P/133)	88.5	86.2	23.7	1,040	273
Sys Performance P133T2A (P/133)	78.2	88.5	28.8	1,140	285
Targem Thunderbolt Office Station (P/133)	65.1	80.2	26.9	1,080	280
Tangent MediaStar 5133 (P/133)	68.2	85.9	23.2	1,130	279
Tatung TCS-5100 (P/133)	66.3	83.6	24.7	1,120	209
Unisys CWP-51333 (P/133)	50.2	55.0	15.1	771	213
USA Flex PT133 Multimedia Special (P/133)	66.6	82.9	21.2	1,040	285
Vektron Optima Station P133 (P/133)	67.5	84.5	22.8	1,070	270
HIGH-END MACHINES (PENTIUM/150 AND PENTIUM/166)					
ACMA zPower 166 (P/166)	68.0	85.2	23.2	1,170	303
ACW P5-166BP (P/166)	43.4	59.7	26.9	1,040	303
AMAX Powerstation 166F (P/166)	77.4	100.6	31.9	1,290	327
AST Bravo MS 5166 (P/166)	71.3	85.8	33.0	1,070	316
Austin PowerPlus 166 (P/166)	59.3	75.9	23.4	782	323
Blue Star Eclipse P-166 (P/166)	67.5	82.8	26.5	1,150	293
CompuTrend Premio Triton P166 (P/166)	78.7	96.9	30.8	1,190	309

BETTER ►

BETTER ►

BETTER ►

BETTER ►

BETTER ►

N/A—Not applicable: The system did not come with a CD-ROM drive. (1) With an Action, Indeo, 320 x 240, 30-fps, 600-Kbps clip.

(2) With an Action, Indeo, 160 x 120, 30-fps, 300-Kbps clip scaled to full screen.

burst counter that can be used to increment column addresses for very fast burst access, and it allows new memory accesses to be initiated before the preceding access has been completed. The SDRAM's burst length and latency is fully programmable via an on-chip mode register.

The AST unit uses SGRAM. In addition to the improvements of SDRAM, SGRAM adds support for masked write and block write. These are features specifically used in graphics accelerators. *Masked writes* reduce or eliminate the need for read-modify-write operations to memory, and *block writes* expedite foreground/background fills such as color expansion for text.

With the implementation of these new types of memory, the AST and Polywell PCs posted top-ten Graphics WinMark 96 scores. The Royal machine did extremely well on our Graphics WinMark tests, posting the highest score in the Pentium/133 class.

ZD Disk WinMark 96 For this roundup, we received 23 units with SCSI hard disks, of which 22 were found in Pentium/166 PCs. On the average, in the Pentium/166 class, machines with SCSI hard disks posted Disk WinMark scores that were 5 percent better than those achieved by systems equipped with EIDE disks. The performance boost gained from SCSI hard disks is evinced in the AMAX Powerstation 133F. This PC used a Quantum Atlas XP32150S Fast SCSI-2 disk, and its Disk WinMark score rivaled the best Disk WinMark scores of the Pentium/166 class.

Although SCSI can give a performance boost, you must make sure you set it up correctly. The Austin PowerPlus 166 came with a Seagate ST32550W Fast/Wide SCSI-2 hard disk paired with an Adaptec AHA-2940UW ultrawide controller: a disk subsystem that should have given the unit a top score. Unfortunately, the 32-

continues

ZD CPUMARK ₉₆ Score	ZD CD-ROM WINMARK 96 Score	CD-ROM			HIGH-QUALITY ACTION INDEX ¹		FULL-SCREEN SCALING ²		MEDIUM-QUALITY ACTION CINEPAK ³	
		Sequential 16K Read KBps ▲	Access Time ms ▼	CPU Utilization ▼	Frames Dropped ▼	CPU Utilization ▼	Frames Dropped ▼	CPU Utilization ▼	Frames Dropped ▼	CPU Utilization ▼
217	476	612	166	35%	0	70%	437	99%	0	47%
280	562	918	168	47%	0	61%	0	70%	0	44%
272	489	907	213	62%	0	68%	0	71%	0	47%
256	604	922	162	52%	0	64%	305	98%	0	65%
285	503	913	215	50%	0	66%	0	69%	0	42%
290	463	611	196	36%	0	67%	0	68%	0	45%
277	407	676	253	33%	84	62%	0	69%	0	39%
166	323	611	404	42%	0	78%	142	100%	0	53%
282	615	911	181	38%	0	55%	0	63%	0	40%
289	521	918	210	46%	0	59%	318	98%	0	41%
267	416	898	225	68%	0	75%	0	71%	4	51%
290	622	918	167	47%	0	53%	0	60%	0	37%
284	609	919	170	47%	0	65%	0	73%	0	46%
281	587	919	184	47%	0	56%	0	60%	0	40%
270	437	864	245	44%	0	61%	0	68%	0	48%
201	414	611	218	30%	0	83%	295	99%	0	60%
271	491	894	214	61%	0	66%	0	70%	0	48%
272	529	919	205	42%	0	39%	0	19%	0	27%
327	612	919	177	30%	0	61%	0	62%	0	39%
296	575	1,020	149	82%	0	76%	0	83%	0	58%
328	620	909	152	39%	0	57%	0	63%	0	42%
314	570	925	236	40%	0	58%	272	100%	0	41%
328	572	918	184	29%	0	53%	0	40%	0	43%
274	391	609	285	40%	0	68%	59	98%	0	51%
290	614	919	173	46%	0	65%	0	65%	0	45%

BETTER ►

BETTER ►

x 768)

(3) With an Action, Cinepak, 320 x 240, 30-fps, 300-KBps clip

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- PCI Bus Architecture
- Smart Lithium Ion Battery with Advanced Power Management
- 128-bit PCI Graphics Accelerator, 1MB Equivalent Video RAM
- 2 Type II/1 Type III PCMCIA Slots
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- 16MB RAM (40MB Max RAM)
- 256KB L2 Cache
- 810MB Removable Hard Drive (1.2GB Max)
- Smart Lithium Ion Battery with Advanced Power Management
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BENCHMARK TESTS

continued

bit Windows 95 driver for the AHA-2940UW adapter was not loaded. This caused the drive to run in 16-bit DOS-compatibility mode. The Austin system's Disk WinMark 96 score of 782 was significantly lower than it should have been (about 40 percent lower, judging by similarly equipped PCs).

Using hard disks with slower rotational speeds and therefore higher latencies can also be detrimental to disk performance. The Austin PowerPlus 133 had a Conner CFS1275A, and the NEC PowerMate V133 had a Conner CFS1621A: Both are Enhanced IDE drives with 3,600-rpm rotational speeds. These two machines placed at the bottom of the charts on our Disk WinMark tests among Pentium/133s.

ZD CPUmark₁₆ and CPUmark₃₂ This review afforded us our first look at Intel's new 430 PCI chip set (also called the Triton II). Of the

20 systems that used the Triton II, 19 used the HX version and one—the Dell Dimension XPS P166s—used the VX version. The HX version is the chip set Intel markets for business PCs, while the VX version is marketed for home PCs. Each of these chip sets offers a 64-bit memory path, concurrent PCI, 3-1-1-1 L2 cache burst timing rates, and an 82371SB PCI I/O IDE Xcelerator. The 82371SB offers support for Universal Serial Bus (USB), PIO, and bus-mastering IDE, and it also complies with the PCI 2.1 specification. Implementation of concurrent PCI allows more efficient operation of CPU, PCI, and ISA transactions for faster and smoother multimedia performance.

The HX chip set provides support for up to 512MB of main memory, dual processors, and optional ECC memory support. The HX's integrated memory controller can support a 4-2-2-2 read timing at 60 MHz and a 5-2-2-2 read timing at 66 MHz using EDO DRAM. This is a slight improvement over the Intel 430FX (Triton)

▲ Higher scores represent better performance.

▼ Lower scores represent better performance

Bold type denotes first place.

ZD WINSTONE 96

Score

ZD WINSTONE 32

Score

ZD GRAPHICS WINMARK 96

Millions of pixels per second

ZD DISK WINMARK 96

Score

ZD CPUMARK₁₆

Score

HIGH-END MACHINES (PENTIUM/150 AND PENTIUM/166)

Comtrade Wide SCSI Powerstation (P/166)	78.2	97.8	28.3	1,220	330
CSS Preferred MT 5/166 (P/166)	76.3	93.6	30.7	1,170	303
Data Storage DataStor P5-166 (P/166)	72.4	87.7	25.4	1,040	305
Dell Dimension XPS P166s (P/166)	76.9	94.2	34.5	1,160	333
Dell OptiPlex GXMT 5166 (P/166)	74.7	93.5	28.9	1,110	327
Diamond Office Intelligent 166 (P/166)	77.8	100.1	31.2	1,220	328
Digital Celebris GL 5106ST (P/166)	75.4	89.4	30.7	1,130	303
DirectWave Blue Thunder (P/166)	78.3	97.5	32.5	1,100	328
DTK QUIN-55M/P166 (P/166)	75.1	98.9	31.3	1,180	318
EPS Evolution XLP-166 (P/166)	78.6	103.0	32.2	1,250	332
Everex Step Premier 166 (P/166)	79.6	96.2	32.0	1,210	328
Everex Tempo Select 166 (P/166)	80.5	94.7	28.7	1,200	333
Gateway P5-166 (P/166)	78.8	95.5	31.5	1,200	325
GST Asapogee P166 (P/166)	77.0	96.8	31.2	1,190	331
HD Victoria P-166 (P/166)	72.2	90.2	26.0	1,080	308
Hertz Z-Pent P166e (P/166)	73.0	94.4	25.2	1,210	325
HP Vectra 500 Model 516MCx (P/166)	59.1	78.5	13.9	1,050	309
HP Vectra VL Series 4 5/166 MT (P/166)	72.8	90.9	26.7	1,150	309
HiQuality HIQ P166 Mars Station (P/166)	76.6	98.3	30.7	1,250	331
IBM PC 350 P166 (P/166)	74.3	91.2	33.1	1,150	307
Maximus Magna Graphics Media (P/166)	76.4	90.9	33.4	1,090	327
Maximus Magna SCSI Media (P/166)	79.5	100.0	34.0	1,110	335
Mega Impact 5166PC116MT (P/166)	75.3	95.9	25.2	1,190	311
Micro Express (Cyril 6x86-P166+)	79.8	98.5	30.0	1,190	309
Micron Millennia 166 (P/166)	77.3	94.3	33.8	1,170	313
Micron Millennia Plus (P/166)	78.8	97.5	31.6	1,200	312

BETTER ▶

BETTER ▶

BETTER ▶

BETTER ▶

BETTER ▶

N/A—Not applicable: The system did not come with a CD-ROM drive. (1) With an Action, Indeo, 320 x 240, 30-fps, 600-KBps clip

(2) With an Action, Indeo, 160 x 120, 30-fps, 300-KBps clip scaled to full

chip set's timing of 7-2-2-2 at 66 MHz with EDO DRAM.

The VX chip set differs from the HX in that it supports a maximum of 128MB of main memory. The VX's integrated memory controller can support a read timing of 6-2-2-2 at 66 MHz using EDO DRAM. The VX also supports SDRAM and a read timing rate of 7-1-1-1 at 66 MHz; if implemented aggressively, the VX could attain a read timing rate of 5-1-1-1.

The Dell Dimension XPS P166s used SDRAM for main memory instead of the more commonly used EDO DRAM. The machine's SDRAM and 512K of L2 cache did help it garner a top-ten finish on both CPUmark₁₆ and CPUmark₃₂ tests, but it was not the first-place finish that you might expect from SDRAM's faster burst timings. We assume that further tuning is still needed: Optimal performance from this system, with 512K of pipelined-burst SRAM and fully optimized SDRAM, should put it ahead of today's EDO implementations.

SDRAM was not the only new type of memory we saw in this review. The two Everex Tempo systems used 52-ns Burst EDO (BEDO) DRAM. BEDO differs from EDO in two important ways. First, BEDO adds another latch stage so that data does not have to reach the outputs as a result of the first column-address strobe (CAS) cycle. Second, BEDO includes an internal address counter. This counter allows BEDO to send data in bursts with only the first address of four needed externally.

Supported by a VIA Apollo-VP chip set, the BEDO-equipped Everex Tempo Select 166 and Tempo Select 133 posted near-top results for both CPUmark tests. The VIA VT82C580VP Apollo-VP chip set has specifications similar to (and in some cases exceeding those of) Intel's Triton II chip set. The Apollo chip set offers a 64-bit memory path; it supports up to 512MB of memory, Unified Memory

continues

ZD CPU MARK ₁₆	ZD CD-ROM WINMARK 96	CD-ROM			HIGH-QUALITY ACTION INDEO ¹		FULL-SCREEN SCALING ²		MEDIUM-QUALITY ACTION CINEPAK ³	
		Sequential 16K Read Kbps	Access Time ms	CPU Utilization	Frames Dropped	CPU Utilization	Frames Dropped	CPU Utilization	Frames Dropped	CPU Utilization
Score	Score	▲	▼	▼	▼	▼	▼	▼	▼	▼
328	658	1,070	169	70%	0	64%	0	65%	0	43%
301	639	917	159	53%	0	66%	0	77%	0	47%
305	384	611	312	49%	61	81%	51	84%	3	61%
335	533	918	197	29%	0	53%	0	60%	0	40%
322	418	612	226	35%	0	64%	0	68%	0	50%
327	618	1,020	147	80%	0	73%	0	71%	0	55%
302	366	612	300	42%	0	72%	0	79%	0	51%
335	609	919	167	46%	0	58%	0	65%	0	44%
322	602	919	175	46%	3	61%	13	67%	0	43%
338	666	1,090	170	71%	0	70%	0	66%	0	46%
330	641	913	159	52%	0	62%	0	68%	0	44%
343	647	914	156	51%	0	64%	0	69%	0	46%
328	567	928	227	42%	0	58%	0	66%	0	42%
338	492	918	197	45%	0	60%	0	68%	0	44%
301	605	919	171	30%	0	50%	0	59%	0	37%
327	622	1,030	141	81%	0	69%	438	99%	0	53%
305	420	612	244	48%	0	75%	3	99%	0	53%
305	446	612	215	43%	0	74%	0	78%	0	57%
335	503	919	187	45%	0	62%	0	71%	0	46%
304	585	919	177	30%	0	54%	0	64%	0	42%
332	624	912	170	48%	0	59%	0	66%	0	44%
345	617	912	156	40%	0	55%	0	64%	0	42%
309	648	912	162	37%	0	57%	0	65%	0	43%
308	443	614	209	33%	13	60%	0	86%	0	48%
310	363	918	342	27%	0	54%	0	67%	0	48%
315	636	1,236	118	27%	0	49%	0	63%	0	37%

BETTER ►

BETTER ►

x 768).

(3) With an Action, Cinepak, 320 x 240, 30-fps, 300-KBps clip

BENCHMARK TESTS

continued

Architecture (UMA), concurrent PCI, 3-1-1-1 L2 cache burst timing, USB, PCI 2.1 compliance, and PIO and bus-mastering IDE. The Apollo-VP also matches the Intel HX chip set's memory timings at 60 MHz and exceeds it with a 4-2-2-2 timing at 66 MHz with EDO DRAM. The Apollo-VP adds support for BEDO and up to 2MB of L2 cache, and it also supports Cyrix's 6x86 linear burst mode. Surprisingly, none of the systems equipped with the Cyrix 6x86 processor used this chip set; they all opted for Intel's Triton or Triton II chip set. Unlike the Triton II chip set, the Apollo-VP chip set does not offer support for ECC memory or dual processors.

The use of 512K of L2 cache in PCs that we review has proliferated over time, especially at the high end. In this roundup, 50 units used 512K of L2 cache: 36 in the high-end category and 14 in the midrange. This extra cache (as most mainstream PCs come with 256K) translated to about a 4 percent performance increase among Pentium/166 PCs and about a 7 percent increase among Pentium/133s. This slight increase is in CPUmark performance only, and it

translates to even less of a performance boost when testing total system capability with our Winstone benchmark tests.

Multimedia The write performance of the 430HX and 430VX PCI chip sets has improved over that of the Triton in four ways: deeper CPU-to-DRAM buffers, deeper PCI-to-DRAM buffers, write merging on CPU-to-DRAM writes, and faster retiring to DRAM. The write-merging feature collects multiple byte, word, and Dword cycles and merges them into a single write to DRAM. With larger posting buffers, DRAM availability has less of an impact on write cycles, reducing overall system latencies. When processor writes that are less than 64 bits wide are merged to DRAM, DRAM performance increases on both 16-bit and 32-bit applications. Multimedia compression and decompression code should run slightly faster on systems with this chip set than on systems with the older Triton chip set.

Although the new ATI 264VT chip incorporates x and y scaling and color-space conversion, systems using this chip did not fare well on our multimedia tests. The AST Bravo MS 5166, the Polywell

▲ Higher scores represent better performance.

▼ Lower scores represent better performance.

Bold type denotes first place.

ZD WINSTONE 96

Score

ZD WINSTONE 32

Score

ZD GRAPHICS WINMARK 96

Millions of pixels per second

ZD DISK WINMARK 96

Score

ZD CPUARK₉₆

Score

HIGH-END MACHINES (PENTIUM/150 AND PENTIUM/166)

MidWest Micro PS-100 Office PC (P/166)	62.8	81.7	23.2	903	323
NEC PowerMate P166 (P/166)	71.2	88.0	27.5	1,080	291
NETIS NS100-EO PowerStation (P/166)	63.5	80.9	23.1	1,040	318
NMC Expert Plus 166 (P/166)	68.7	89.8	18.9	1,070	321
Polywell PolyStation 166P (P/166)	69.8	85.8	32.9	1,090	319
Quantex QPS/166 3M-2 (P/166)	70.5	87.2	28.5	1,100	315
Reason Savvy TR/Model Z (P/150)	62.8	77.8	18.8	904	272
Reason Square 5 DP-TR2/HX (P/166)	80.8	103.2	33.3	1,210	335
Reason Square 5 TR/ITX (P/166)	68.5	85.0	21.4	1,100	308
Robotech Cobra XLT/2 P166 (P/166)	75.3	84.7	34.0	1,120	321
Royal Media 96 Pro (P/166)	74.6	93.1	30.8	1,200	313
S.A.B. STA Dual 166 Ultra (P/166)	73.5	98.9	36.3	1,220	334
SMD Mount Olympus (P/166)	75.3	90.8	29.2	1,100	323
SMD Mount Shasta (Cyrix 6x86-P166+)	77.8	88.2	32.1	1,210	320
Swan PowerHouse Deluxe 166 (P/166)	72.0	90.8	24.5	1,080	307
Sys Performance (Cyrix 6x86-P166+)	80.7	95.5	31.1	1,180	322
Tegram Transcendental Virtual Studio (P/166)	76.0	90.8	32.7	1,140	310
Tangent MediaStar 5166 (P/166)	75.2	92.3	28.8	1,170	327
Taking TCS-8900 (P/166)	71.4	88.1	27.9	1,160	312
Unlasy CMT-51667 (P/166)	68.1	81.9	20.2	909	297
Unitek Skywalker (P/166)	71.4	85.9	31.1	934	328
US Computer Freedom LX+ (P/166)	74.7	91.9	28.2	1,150	311
US Computer Patriot LX+ (P/166)	78.1	90.1	28.8	1,090	323
Vektron Power Pro P166 (P/166)	78.2	98.4	28.1	1,200	316

BETTER ►

BETTER ►

BETTER ►

BETTER ►

BETTER ►

N/A—Not applicable: The system did not come with a CD-ROM drive. 1 With an Action, Indeo, 320 x 240, 30-fps, 600-Kbps clip.

2 With an Action, Indeo, 160 x 120, 30-fps, 300-Kbps clip scaled to full

PolyStation 166P, and the Royal Ultra Media Pro all dropped over 200 of the 450 frames on the Full-Screen Scaling test. Apparently the chip or drivers need further testing and tuning.

How We Tested

We tested all systems with 1GB hard disks or larger, quad-speed or faster CD-ROM drives, and 16MB of RAM. We used each vendor's preinstalled graphics driver for 1,024-by-768 resolution with 256 colors, small fonts, and a refresh rate of 75 Hz. We also disabled power management features and removed unnecessary drivers. We defragmented hard disks before each test and let Windows 95 manage virtual memory settings.

We used our benchmark test program **Winstone 96, Version 1.0**, to measure each machine's performance when running typical Windows applications. Winstone 96 measures the time a PC takes to execute a set of application scripts that exercise 13 of the best-selling Windows applications. Winstone weights a given PC's test timings based on the applications' unit market shares; it then de-

rives a composite number and converts it to a relative score. (The score is relative to the performance of a 486SX/25 Dell 425s/P with 8MB of RAM, whose score is defined as 10.)

We also used our new benchmark test program, **Winstone 32, Version 1.0**, to measure units' performance when running 32-bit Windows applications under operating systems such as Windows 95 and Windows NT 3.51. Winstone 32 measures the time a PC takes to execute a set of scripts that utilize eight best-selling 32-bit applications. Like Winstone 96, Winstone 32 then weights a given PC's test timings based on the market share of the applications and converts it to a relative score. Both Winstone tests use the same base machine—the Dell 425s/P—whose score is defined as 10. However, the Winstone 32 base system runs Windows 95 and MS-DOS 7.0, while the Winstone 96 base system runs Windows 3.1 and MS-DOS 6.2.

We used our benchmark test program WinBench 96, Version 1.0, as a measure of graphics, disk, processor, CD-ROM, and motion-video performance under Windows. The **Graphics WinMark 96** score, based

continues

ZD CPUMARK ₉₂		ZD CD-ROM WINMARK 96		CD-ROM		HIGH-QUALITY ACTION INDEO ¹		FULL-SCREEN SCALING ²		MEDIUM-QUALITY ACTION CINEPAK ³		
Score		Score		Sequential 16K Read KBps	Access Time ms	CPU Utilization	Frames Dropped	CPU Utilization	Frames Dropped	CPU Utilization	Frames Dropped	CPU Utilization
				▲	▼	▼	▼	▼	▼	▼	▼	▼
319		491		903	246	62%	0	66%	0	89%	0	53%
287		438		920	190	52%	0	67%	0	71%	0	51%
308		525		913	215	44%	0	59%	0	66%	0	41%
326		351		612	316	29%	0	62%	0	82%	0	51%
323		604		919	163	47%	0	59%	306	100%	0	43%
307		409		684	227	34%	0	63%	0	67%	0	42%
266		369		613	295	40%	0	73%	0	82%	0	48%
337		619		919	165	46%	0	56%	0	62%	0	40%
302		611		919	165	30%	0	54%	0	71%	0	40%
334		619		909	156	39%	0	56%	0	61%	0	42%
309		622		1,020	138	82%	0	74%	0	73%	0	58%
326		611		911	160	40%	0	56%	0	68%	0	43%
326		489		924	224	40%	0	67%	0	71%	0	49%
323		371		612	303	37%	0	64%	0	82%	0	43%
306		409		886	224	54%	8	62%	6	60%	5	38%
329		568		1,020	144	62%	0	78%	0	81%	0	59%
312		618		919	183	47%	0	65%	0	68%	0	46%
327		445		1,200	245	67%	0	63%	0	65%	0	41%
309		432		866	241	44%	0	62%	0	68%	0	47%
301		455		613	169	27%	0	59%	0	69%	0	51%
334		526		914	198	58%	0	69%	0	67%	0	46%
308		611		918	170	41%	0	58%	0	61%	0	38%
324		642		911	160	52%	0	63%	4	99%	0	44%
324		625		1,020	143	81%	0	71%	0	73%	0	54%

BETTER ►

BETTER ►

x 768]

3 With an Action, Cinepak, 320 x 240, 30-fps, 300-KBps clip

BENCHMARK TESTS

continued

on 115 tests of Windows GDI functions, represents the performance of each machine's graphics subsystem under Windows. Graphics WinMark scores are reported in millions of pixels per second. The **Disk WinMark 96** score, based on extensive application profiling, represents the disk subsystem's performance under Windows.

The **CPUmark₁₆** and **CPUmark₃₂** scores gauge the speed of a PC's processor subsystem—which includes the CPU, secondary cache, and system RAM—under 16- and 32-bit operating systems, respectively.

The **CD-ROM WinMark 96** tests gauge the performance of a machine's CD-ROM subsystem, which includes the CD-ROM drive, its adapter, and its required software drivers. This test is based on a profile of six of today's most popular Windows CD-ROMs.

We report the results of the **CD-ROM Sequential 16K Read** test, which measures the throughput of the CD-ROM subsystem as it reads 16K blocks of data on a CD-ROM. The **Access Time** score measures the CD-ROM drive's performance while randomly

accessing 2K files from the entire CD-ROM.

The **CD-ROM CPU Utilization** score represents the percentage of the processor's bandwidth occupied by servicing the CD-ROM subsystem while it retrieves data. To determine this score, WinBench 96 uses a default block size of 16K. The transfer rate defaults to the maximum rate of your particular CD-ROM subsystem. WinBench 96 then calculates this transfer rate before it runs the actual tests. WinBench 96 also includes Video Test, a suite of 33 video clips that measure the PC's ability to play full-motion AVI files. Video Test allows you to test video-playback performance with two types of clips at a variety of data and frame rates, using either the Indeo or Cinepak codec.

We report results from the **High-Quality Action Indeo** test, which uses an Action Indeo, 320-by-240, 30-frame-per-second, 600-KBps video clip; the **Full-Screen Scaling** test, which uses an Action Indeo, 160-by-120, 30-fps, 300-KBps clip; and the **Medium-Quality Action Cinepak** test, which uses an Action Cinepak, 320-by-240, 30-fps, 300-KBps clip.

968-based graphics cards with 4MB of VRAM, however, both units garnered below-average scores in their CPU classes on our Graphics WinMark tests.

ACMA includes Microsoft Office Professional with these PCs. The units come with a three-year-parts, one-year-labor and on-site-service warranty.—*Charles Lin*
sPower 133. Direct price: \$2,699. **zPower 133.** Direct price: \$3,199. **zPower 166.** Direct price: \$3,999. ACMA Computers Inc., Fremont, CA; 800-786-6888, 510-623-1212; fax, 510-623-0818; <http://www.acma.com>. **Circle 441** on reader service card.

All Computer Warehouse

ACW P5-166BP

The ACW P5-166BP (\$3,198 street), from All Computer Warehouse, is an all-purpose corporate desktop machine. A conventional 166-MHz Pentium tower system, it has an average price but some compelling extras such as Microsoft Office and a 17-inch MAG monitor.

Based on a Tyan motherboard with Intel's Triton chip set and 512K pipelined-burst L2 cache, the P5-166BP posted average scores on both CPUmark test suites. On our Winstone 32 and Winstone 96 tests, however, the ACW produced two of the lowest scores

of this roundup. This happened because its graphics card driver was configured to its default settings, which forced the control panel to load upon entering Windows 95 and consequently dragged down performance. The driver problem is remedied by removing the graphics control panel from the startup group.

ACW equipped the unit with a 1.5GB EIDE hard disk, a Diamond Stealth64 Video graphics adapter with 2MB of VRAM, and a Toshiba 6.7X SCSI-2 CD-ROM drive. These components helped the unit attain average Graphics, Disk, and CD-ROM WinMark 96 scores.

The system also features a Creative Labs Sound Blaster 16 FM synthesis audio card, MLI 691H speakers, and a 28.8/14.4-Kbps data/fax modem. Microsoft Office Professional with Bookshelf for Windows 95 and Microsoft Small Business Solutions Pack complete the package.

The P5-166BP has a one-year warranty. On-site service for a single year is \$129.95.—*Bruce Brown*

ACW P5-166BP. Street price: \$3,198. All Computer Warehouse, City of Industry, CA; 800-775-1953, 818-369-4181; fax, 818-961-7462; allcomp@allcomp.com. **Circle 442** on reader service card.

AMAX Engineering Corp.

Powerstation 133F, Powerstation 166F

AMAX Engineering Corp.'s \$3,999 Powerstation 133F and the \$4,299 Powerstation 166F are both excellent performers

designed for corporate users. The 133-MHz Powerstation 133F is intended as a mainstream, midlevel corporate system, while the 166-MHz Powerstation 166F is suited for more processor-intensive applications. Both systems use huge, well-finished tower cases packed with top-notch components, which explains their fairly

high prices and impressive performance.

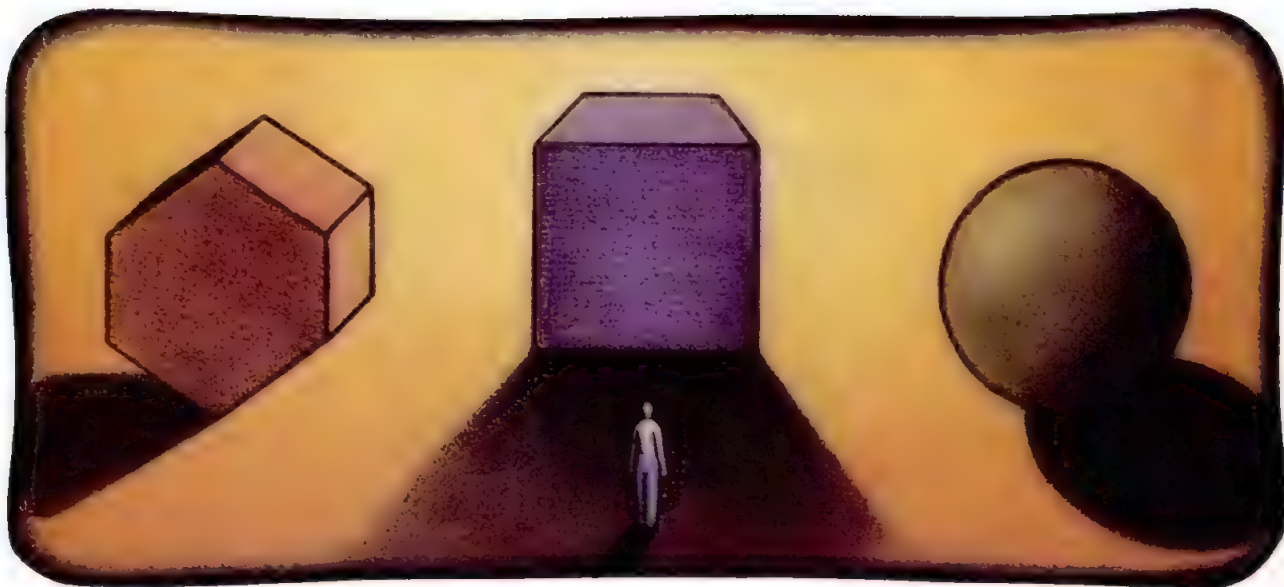
Based on identical motherboards with Intel Triton chip sets and 512K pipelined-burst L2 cache, the Powerstations each had 2GB 7,200-rpm Fast SCSI-2 hard disks with Adaptec controllers. Number

Nine Imagine 128 graphics cards with 4MB of VRAM drove both graphics subsystems. The Powerstation 133F came with a 15-inch Impression monitor, while the Powerstation 166F included a 17-inch model.

The units' performances reflected their componentry. Test results showed class-leading Disk WinMark 96 scores for both machines, and above-average scores on most other tests.

These PCs include a 6X Plextor SCSI CD-ROM drive, a 16-bit audio card, Altec Lansing ACS5 speakers, and a 28.8/14.4-Kbps data/fax modem. The units are also bundled with Microsoft





Buying the PC That's Right for You

BASIC MEMORY GUIDELINES: If your operating system of choice is Microsoft Windows 95, you shouldn't expect to purchase a PC with less than 16MB of RAM. Many vendors still sell 8MB configurations with their low-end machines, even though Windows 95 operates much more efficiently with 16MB of system memory. Some vendors will offer discounts on memory at the point of purchase.

Processor cache memory (or *L2 cache*) is very important and is also a feature that some vendors omit from their lower-end PCs. The add-on cost of 256K of synchronous or pipelined-burst L2 cache at the point of purchase is about \$100, and it's well worth the cost to boost overall system performance. Slower asynchronous cache is less expensive but provides only a marginal performance boost over a cacheless configuration. Quite a few machines here offer 512K of L2 cache, but we've found through testing that this extra cache provides only a small overall performance boost (about 3 percent). Unless you're running applications that are extremely processor-intensive or multithreaded, 512K of L2 cache may not be necessary.

THE MIDRANGE PC (average price, about \$2,500): If you're buying a PC to perform basic tasks such as word processing, light spreadsheet work, or electronic mail, a midrange system should meet your requirements. For this roundup, we defined the midrange as systems with 120- and 133-MHz Pentium or equivalent processors (from Cyrix, look for the 6x86-P120+ or 6x86-P133+), 16MB of RAM, at least 1GB hard disks, and quad-speed or faster CD-ROM drives.

If you examine the configurations of the machines we tested in this category, you'll find that the list of options varies widely by vendor. The pricing sweet spot, however, is about \$2,500,



This guide outlines the basic types of PCs available today. To compare the performance levels and features offered by the 44 midrange and 57 high-end Pentium- and Cyrix 6x86-equipped systems we tested for this roundup, turn the page.

and that amount (using mail-order pricing as a guideline) will net you a PC with a 1.3GB EIDE hard disk, a 2MB graphics card, a 6X CD-ROM drive, a 15-inch monitor, and a basic multimedia setup (FM sound card and low-end, typically unpowered speakers).

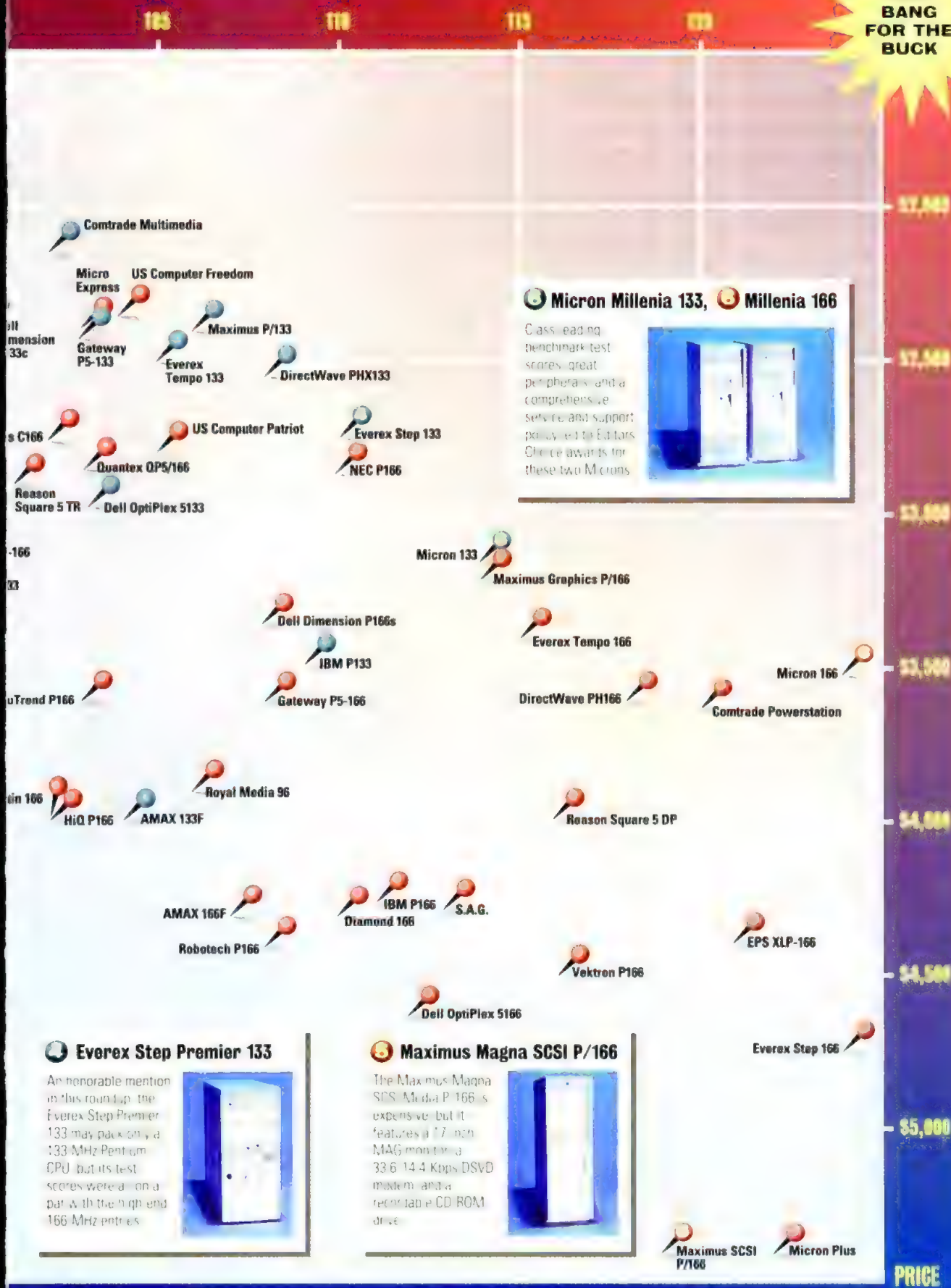
THE HIGH-END PC (average price, about \$3,500): If a midrange PC doesn't have the horsepower to keep up with your computing needs, you should consider the move up to a high-end PC. We define the high end here as systems with Pentium/150 and Pentium/166 CPUs (the Cyrix equivalents are the 6x86-P150+ and the 6x86-P166+).

The configurations of the high-end machines we review here vary widely. In this category, the pricing sweet spot is about \$3,500; for the extra money, you can expect to step up to a PC with a 1.5GB or larger hard disk, a 2MB to 4MB graphics card, a 6X or faster CD-ROM drive, a 17-inch monitor, and a more advanced audio setup (wavetable sound card, powered speakers with subwoofer).

NOTEBOOK WITH DOCKING STATION: If you find yourself working on the road more often than at your desk, a notebook with a docking station is a viable computing option that will save you the cost of purchasing two machines. Many offer systems with 1GB or larger hard disks, 4X or 6X CD-ROM drives, and 64-bit graphics.

Most leading notebook vendors also offer docking stations with PCI and ISA expansion slots, additional drive bays, and even built-in speakers, so you can outfit your stationary computing environment to suit your needs for a fraction of the cost of a second PC. High-end docking stations such as these sell for about \$750 each.

**MOST
BANG
FOR THE
BUCK**



6 Micron Millennia 133, 6 Millennia 166

Class-leading benchmark test scores, great peripherals, and a comprehensive service and support policy led to Editors' Choice awards for these two Microns.



Everex Step Premier 133

An honorable mention in this roundup, the Everex Step Premier 133 may pack only a 133 MHz Pentium CPU, but its test scores were all on a par with the high-end 166 MHz entries.



3 Maximus Magna SCSI P/166

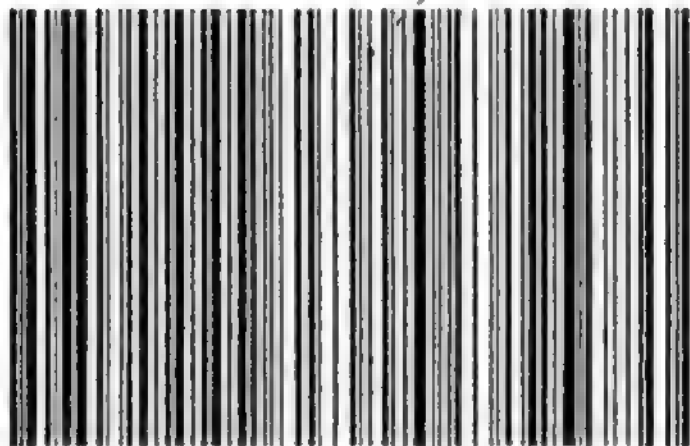
The Maximus Magna SCSI Model P/166 is expensive, but it features a 17-inch MAG monitor, a 33.6/14.4 Kbps DSVD modem, and a removable CD-ROM drive.



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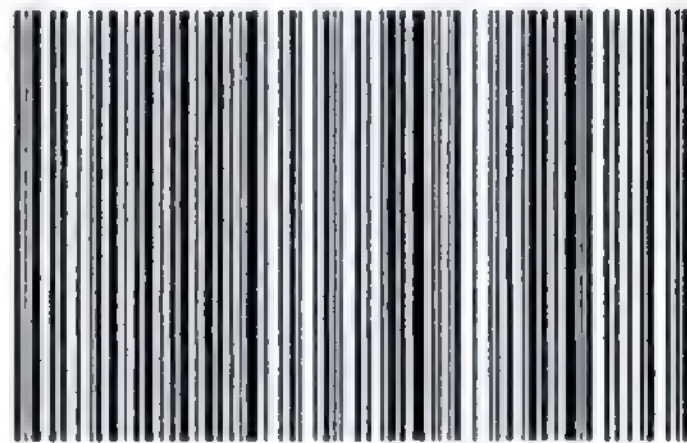
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Foldout slip-sheet

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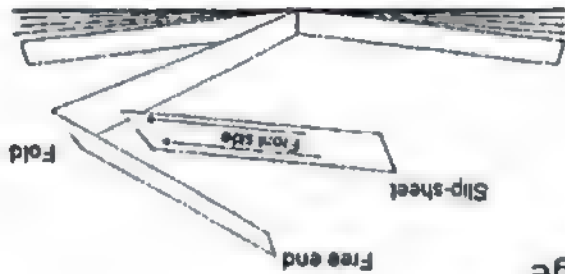
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4. Close the page and slip-sheet



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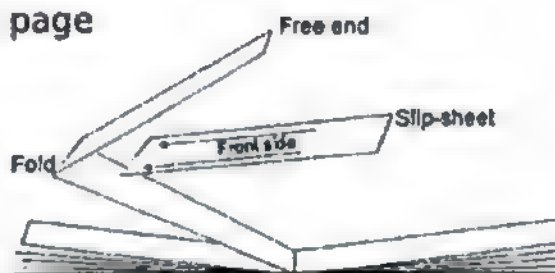
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Desktop PCs: Price, Performance, and Features

PERFORMANCE/
FEATURES

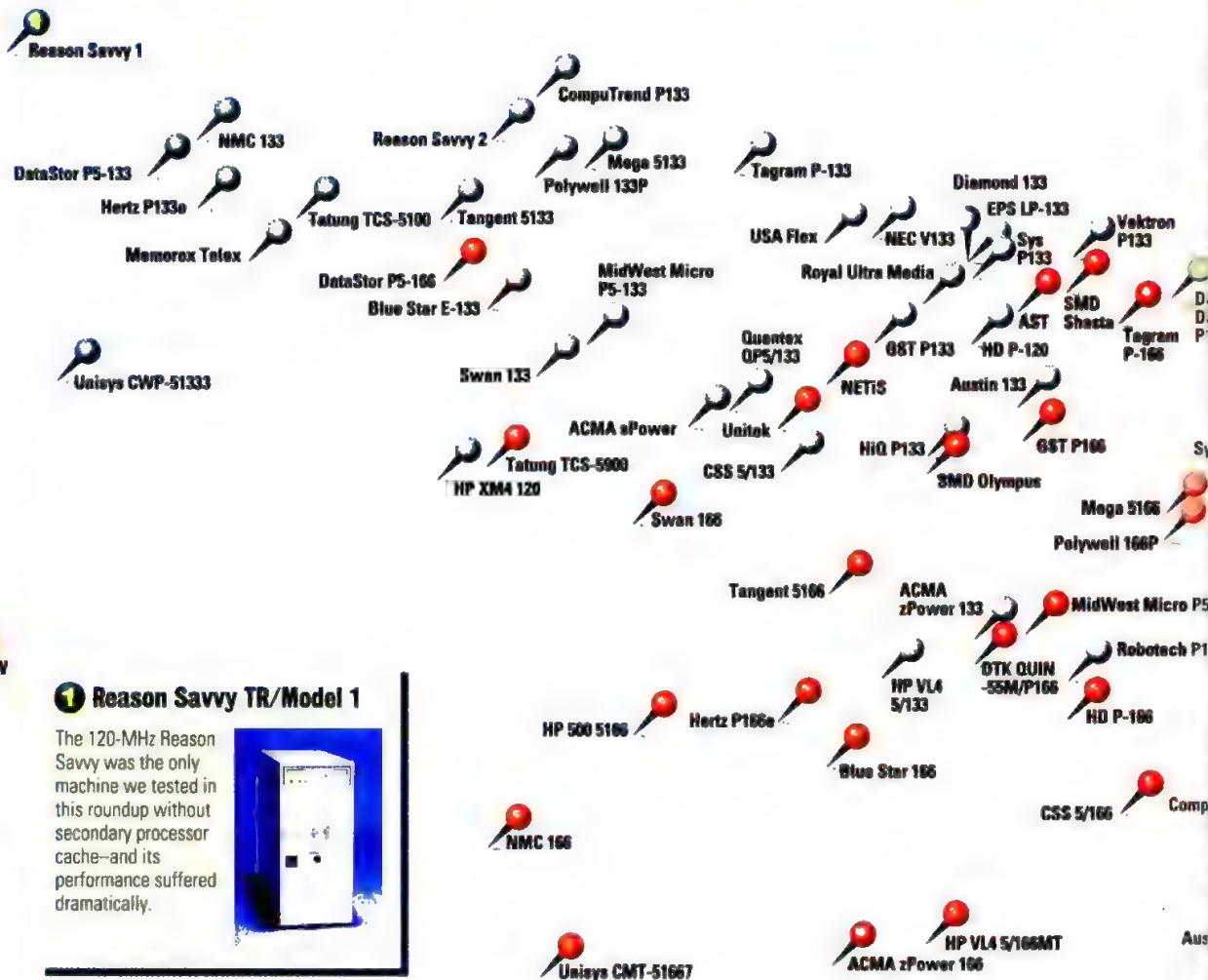
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85

90

95

100



2
ACW

1 Reason Savvy TR/Model 1

The 120-MHz Reason Savvy was the only machine we tested in this roundup without secondary processor cache—and its performance suffered dramatically.



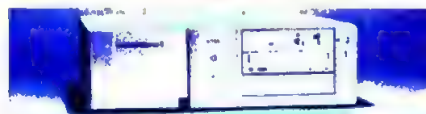
2 ACW P5-166BP

The ACW P5-166BP's performance/features score (74) was negatively affected by low test scores, but that situation can be remedied easily with a graphics card driver tweak.



3 Dell Dimension XPS P133c

Our Editors' Choice for value, the 133-MHz Dell Dimension XPS P133c may cost just \$2,379, but it's fully loaded with top-notch hardware and software, including Microsoft Office Professional for Windows 95



Digital

Midrange and High-End Pentium PCs

Our price/performance index chart historically has provided an excellent measure of overall system value. This is because we consider every aspect of a system when calculating the performance/features score. Not only does the machine's performance on our benchmark tests account for a significant portion of the score (see "The Data Points," below), but its tangible features, such as hard disk size and amount of graphics card memory, are calculated into the score as well.

When figuring the performance/features score, we also take into account the individual vendor's service and support policies. We consider the availability of on-site service and toll-free technical support, as well as the terms of parts coverage, when calculating the score.

For further information on vendor service and support, we suggest you consult the article on our latest reader Service & Reliability survey. (For the most recent results, see our issue of July 1995; our issue of July 1996 will contain updated results from our new survey.) Through these surveys, we can measure our readers' satisfaction with a vendor's service and support offerings, as well as provide a direct measure of product reliability by asking respondents how many times their PCs needed repairs during the first 12 months of use. But bear in mind that vendors' Service & Reliability scores do *not* factor into the price/performance index scores, because not all vendors received the minimum of 50 responses required for inclusion in the survey results. For vendors that do appear in the survey, the results appear with the system reviews.

By consulting the Service & Reliability scores and the product reviews in this article as additional sources of information, you should get a comprehensive view of all aspects of a PC to aid you in your buying decision. Our price/performance index ratings are definitely great to start with,

but they may not provide all of the information you need before buying a new PC.

EDITORS' CHOICES

Our first Editors' Choice proves that you don't have to spend a lot of money to get a Pentium-powered PC. The \$2,379 Dell Dimension XPS P133c was a competitive per-



former on our benchmark tests, thanks to well-chosen components including a 1GB Quantum Fireball hard disk, 256K of pipelined-burst L2 cache, and a Number Nine Motion 771 graphics accelerator card. With a 15-inch monitor, a 6X CD-ROM drive, Altec Lansing speakers, a 28.8/14.4-Kbps fax modem, and Microsoft Office Professional 95, you're ready to roll.

Two entries from Micron Electronics also captured Editors' Choice

awards. The \$3,517 Micron Millennia 166 offers the best combination of price, performance, and features among the high-end machines, while the \$3,148 Micron Millennia 133 is a great pick for the midrange.

Both Micron PCs posted great scores on our benchmark tests and came loaded with a number of new high-end components such as Intel's 430HX PCI chip set, Number Nine's new Imagine 128 Series 2 graphics accelerator card, and 17-inch monitors with high vertical refresh rates.

HONORABLE MENTION

The \$2,749 Everex Step Premier 133 received an honorable mention in this roundup and posted class-leading scores on our benchmark tests. You may be purchasing a Pentium/133 processor with this machine, but its performance was on a par with the average Pentium/166 we tested.

The Data Points

We calculate price/performance data for each PC evaluation we conduct. Depending on the story's focus (servers, notebooks, business or home PCs), the features that make up the performance/features score will vary.

All of the features counted, plus benchmark test scores, are given various weightings to create the final numbers, which always total 100 percent. Winstone 96 and Winstone 32 scores represent overall system performance with 16-bit and 32-bit applications, respectively; that is why each test is given a weight of 20 percent. CD-ROM performance accounts for another 10 percent. Monitor features, including Energy Star compliance, noninterlaced refresh rates, and measured screen size, make up 14.5 percent. The warranty on parts and labor, on-site service, and technical-support options count for 11 percent.

The presence of different types of ports makes up about 7 percent of the score; this includes the number of dedicated mouse ports, on-board SCSI ports, serial ports, and infrared ports. Extended Capabilities Port (ECP) and Enhanced Parallel Port (EPP) options are also given points. These last two specifications fall under the IEEE 1284 specification for parallel ports; they provide two-way communication and can achieve throughput in excess of 500 Kbps, as opposed to a standard parallel port, whose peak throughput is only 150 Kbps.

Extra points are contingent on a system's hard disk capacity, the amount of graphics memory present, the sound card synthesis type supported, and the type and speed of modem included, if any. If a network adapter card or any type of backup media is included, credit is also given. Note, however, that these last two features are not required.

LOOKING FOR THE BEST PC'S ON THE MARKET?



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Warranty from Micron



January 1995



May 30, 1995
Millennia P120



January 9, 1996
Millennia



December 1995
Millennia P133

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ity, you really have to look inside. Micron focuses on superior engineering, from picking outstanding performance you can count on. Micron's first-tier reliability status proves it.

RELIABILITY RANKINGS

1ST TIER



2ND TIER



3RD TIER



Source: PC World Reliability & Service Monitor, May 20 - November 20, 1995



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All sales are subject to Micron's standard limited warranties and terms and conditions of sale. Copies of our limited warranties may be obtained by calling Micron or at <http://www.mei.micron.com>.



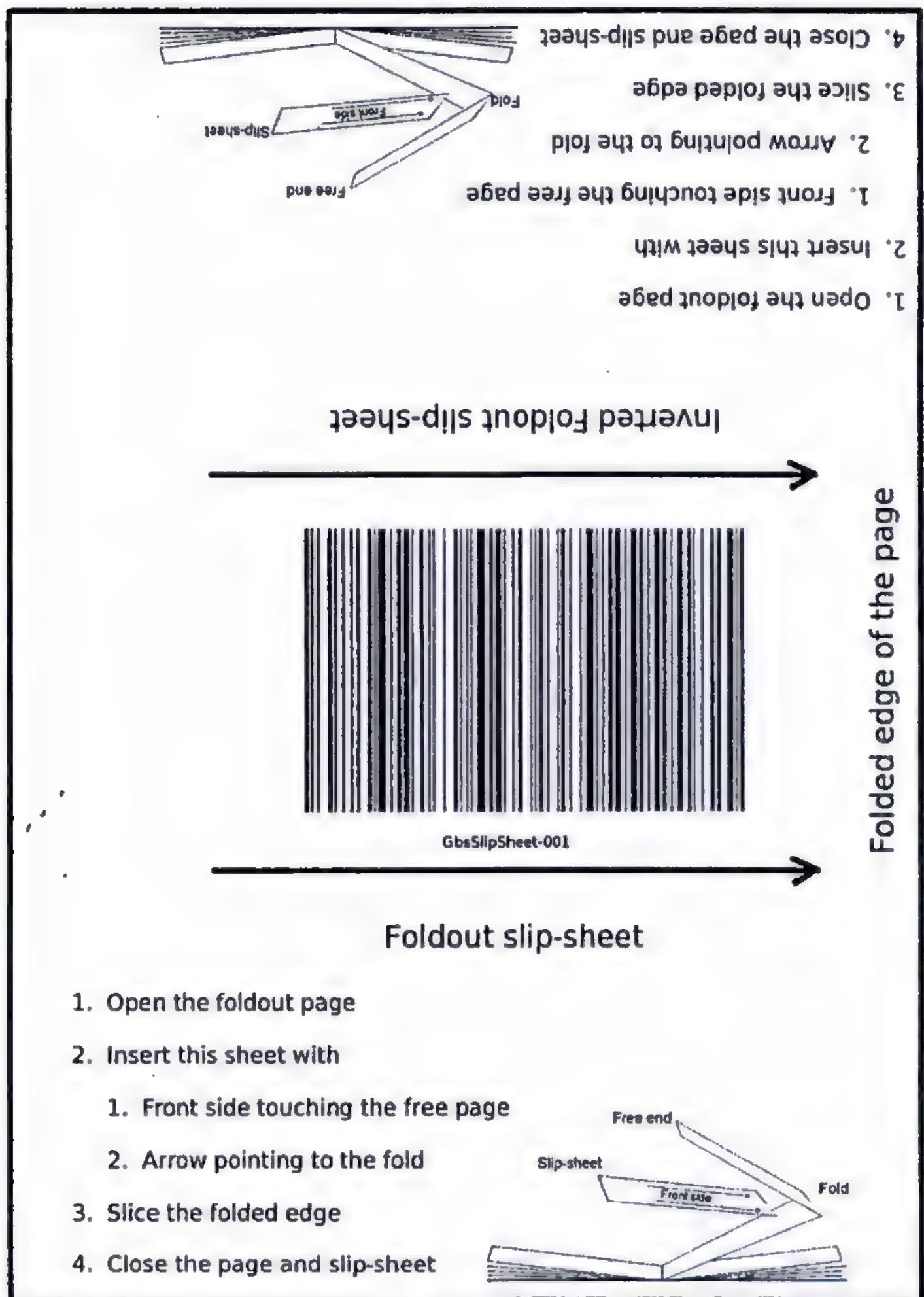
MS WINDOWS® 95 &
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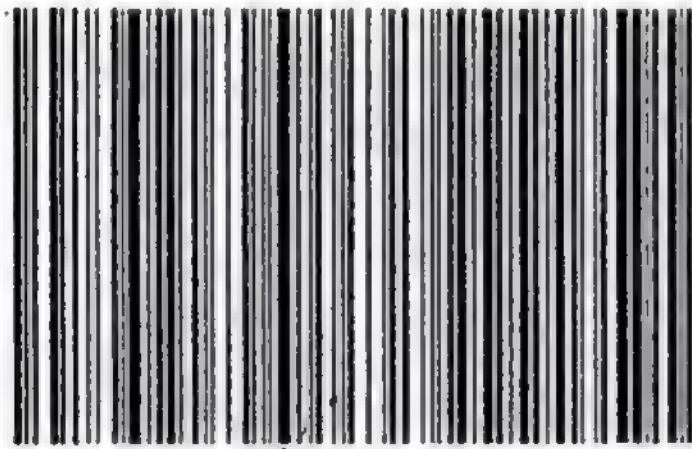
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Gbs5lpBack-001B

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WHAT A COINCIDENCE, WE

To get an idea of how Micron Electronics products have achieved leadership status in reliability, we selected the best components available to rigorous performance and reliability tests. The result is a

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MILLENNIA P166

- Intel 166MHz Pentium® processor
- 512KB pipelined burst cache, flash BIOS
- 8X EIDE CD-ROM drive, 3.5" floppy drive
- 16-bit stereo sound & speakers
- PCI 64-bit 3D video, MPEG, 2MB EDO
- *Tool-free* mini-tower or desktop
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- Microsoft Windows® 95 CD & MS Plus! CD
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 With 133MHz Pentium Processor subtract '200

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- Intel 200MHz Pentium Pro processor
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- PCI 64-bit video, MPEG, 2MB EDO
- *Tool-free* mini-tower or desktop
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- Microsoft Windows NT Workstation 3.51 CD
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- PCI 64-bit 3D video, MPEG, 2MB EDO
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- Intel 200MHz Pentium Pro processor
- 256KB internal cache, flash BIOS
- PCI 32-bit Ultra SCSI Fast-20 controller
- 8X SCSI-2 CD-ROM drive, 3.5" floppy drive
- 16-bit stereo sound & speakers
- PCI 64-bit video, MPEG, 2MB EDO
- *Tool-free* mini-tower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows NT Workstation 3.51 CD
- Microsoft Office Pro 95 & Bookshelf 95 CDs
- 5-year/3-year Micron Power warranty*

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 • 2GB Fast SCSI-2 hard drive
 • 15" Micron 15FGx, .28dp (13.7" display)

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• 64MB RAM
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Office Professional with Bookshelf for Windows 95 and Microsoft Small Business Solutions Pack.

AMAX Engineering's three-year-parts, one-year-labor warranty includes on-site service for the first year.—BB

Powerstation 133F. Direct price: \$3,999.

Powerstation 166F. Direct price: \$4,299.

AMAX Engineering Corp., Fremont, CA; 800-800-6328, 510-651-8886; fax, 510-651-4119; <http://www.amax.com>. Circle 443 on reader service card.

AST Computer

Bravo MS 5166

AST Computer's Bravo MS 5166 (\$2,415 street), aimed at mainstream corporate buyers, showcases some new technology in its slimline case. The DMI-compliant Bravo performed well in its 166-MHz class, especially on our Graphics WinMark 96 test, where it posted a top-ten score. AST also sells the Advantage! line of home PCs and the Premia line of Pentium Pro-based Windows NT workstations.

The Bravo features Intel's new Triton II chip set, which is found in only 20 percent of the PCs we tested. More intriguing, however, was the unit's integrated ATI 264 VT PCI graphics chip set, which uses 2MB of synchronous graphics RAM (SGRAM), a new type of fast and low-cost graphics memory. Also integrated on the motherboard is a Vibra-16 audio chip set with FM synthesis support.

The Bravo posted average scores on most tests, including our Winstone 96 and Winstone 32 measures. Its integrated SGRAM-powered graphics came through, however: The unit garnered an above-average Graphics WinMark 96 score.

The Bravo has other interesting characteristics as well: Command Center, a combination of software and hardware that provides password protection during



boot-up; McAfee's Virus Scan; and Verbox Listen for Windows, a utility that enables the system to respond to voice commands. AST also offers a dual hot load of both Windows for Workgroups and Windows 95 with the Bravo, so you can choose your OS.

The system has a three-year warranty on parts and labor, which includes on-site service for the first year.—CL

Bravo MS 5166. Street price: \$2,415. AST Computer, Irvine, CA; 800-876-4278, 714-727-4141; fax, 714-727-8597; <http://www.ast.com>. Circle 444 on reader service card.

Austin Direct

PowerPlus 133, PowerPlus 166

Austin Direct's \$2,649 Austin PowerPlus 133 and \$3,999 Austin PowerPlus 166—sold as midrange home, small-business, and government machines—offer impressive warranties, 17-inch monitors, and 28.8/14.4-Kbps data/fax V.34 modems. But poor test performance might overshadow these assets. Austin Direct also sells a family of PowerSystem PCs that target entry-level customers in home or corporate markets. And by the time you read this, a PowerPro line will provide Austin Direct customers with high-end Pentium Pro workstations.

The PowerPlus systems' below-average scores on each Winstone measure and their

memory clock with the CPU's clock, avoids the extra clock cycles that standard DRAM needs.

Hard disk interface EIDE denotes Enhanced IDE, an extension to IDE that supports faster transfer rates, higher disk capacities, and mass-storage devices other than hard disks. Fast ATA-2 denotes Seagate's EIDE-like specification for increased transfer rates and larger capacities. Fast SCSI-2 supports transfer rates up to 10 MBps; Fast/Wide SCSI-2 supports transfer rates up to 20 MBps; and Ultra SCSI (also known as SCSI-3, Fast-20, or Fast-40) supports transfer rates from 20 to 40 MBps, depending on the disk.

poor showings on our Disk WinMark 96 tests resulted from their hard disk subsystems. The 133's 3,600-rpm disk was simply too slow. The 166 had a 7,200-rpm 2GB Fast/Wide SCSI-2 disk, but Austin failed to install the proper driver for its Adaptec ultrawide controller, so the disk operated in 16-bit MS-DOS compatibility mode. The units' Video Logic GraphixStar 400 graphics cards yielded below-average scores on our Graphics WinMark 96 tests, but CD-ROM WinMark 96 scores were average thanks to the TEAC 6X drives.

Both PCs offer a healthy software bundle, including Reuters Money Network and NetCruiser. The PowerPlus PCs have a three-year parts-and-labor warranty with one year of on-site service.—CM
PowerPlus 133. Direct price: \$2,649. **PowerPlus 166.** Direct price: \$3,999. Austin Direct, Austin, TX; 800-752-1577, 512-339-3500; fax, 512-454-1357; <http://www.austindirect.com>. Circle 445 on reader service card.



SERVICE & RELIABILITY

AST Computer

Reliability	Better than average
Repair	Better than average
Technical support	Average
Percent needing repair	Better than average

SERVICE & RELIABILITY

Austin Direct

Reliability	Average
Repair	Average
Technical support	Average
Percent needing repair	Worse than average

SUMMARY OF FEATURES

Pentium PCs

■ YES ■ NO

Products listed in review order

	ACMA sPower 133	ACMA zPower 133	ACMA zPower 166	All Computer Warehouse ACW PS-166BP	AMAX Powerstation 133F	AMAX Powerstation 166F	AST Bravo MS 5166	Austin PowerPlus 133
Price of tested configuration	\$2,699 (direct)	\$3,199 (direct)	\$3,999 (direct)	\$3,198 (street)	\$3,999 (direct)	\$4,299 (direct)	\$2,415 (street)	\$2,649 (direct)
Processor	Pentium/133	Pentium/133	Pentium/166	Pentium/166	Pentium/133	Pentium/166	Pentium/166	Pentium/133
Installed RAM	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Hard disk manufacturer and model	Quantum Fireball 1280A	Quantum Fireball 1280A	Quantum Fireball 1280A	Western Digital Caviar AC31600	Quantum Atlas XP32150S	Quantum Atlas XP32150S	Seagate ST32140A	Conner CFS1275A
Capacity and interface	1.2GB Fast ATA-2	1.2GB Fast ATA-2	1.2GB Fast ATA-2	1.5GB EIDE	2GB Fast SCSI-2	2GB Fast SCSI-2	2GB Fast ATA-2	1.2GB EIDE
Graphics adapter	Diamond Stealth64 Video 2201	Diamond Stealth64 Video VRAM 3240	Diamond Stealth64 Video VRAM 3240	Diamond Stealth64 Video VRAM 3240	Number Nine Imagine 128	Number Nine Imagine 128	Integrated 264 VT	Video Logic GraphicStar 400
Memory	2MB EDO DRAM	4MB VRAM	4MB VRAM	2MB VRAM	4MB VRAM	4MB VRAM	2MB SGRAM	2MB DRAM
Monitor (and screen diagonal measured/claimed, in inches)	Princeton EO15 (13.8, 15)	MAG InnoVision DX15T (14, 15)	MAG InnoVision MXP17F (16, 17)	MAG InnoVision DX1795 (16, 17)	Impression 5628G (13.9, 15)	Impression 1772G (16, 17)	AST Vision 5L (13.5, 15)	Smile CB1716SL (16, 17)
CD-ROM drive (speed)	Toshiba (4X)	TEAC (6X)	TEAC (6X)	Toshiba (6.7X)	Plextor (6X)	Plextor (6X)	Torisan (4X)	TEAC (6X)
Sound adapter	Creative Labs CT2940	Integrated (Vibra 16)	Integrated (Vibra 16)	Sound Blaster 16	Sound Blaster 16	Sound Blaster 16	Integrated (Vibra 16S)	Crystal Lake Multimedia 220
Speakers	Altec Lansing ACS5	Altec Lansing ACS5	Altec Lansing ACS5	MIDI Land MLI-891H	Altec Lansing ACS5	Altec Lansing ACS5	Labtech LCS-800	Audiophile AA-941
Installed external RAM cache	256K	512K	512K	512K	512K	512K	256K	256K
Type of cache	Asynchronous	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
Motherboard manufacturer	Intel	Intel	Intel	Tyan	Impression	Impression	Intel	Intel
Chip set manufacturer	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430HX	Intel 430FX
Standard warranty on parts/labor	3 years/1 year	3 years/1 year	3 years/1 year	1 year/1 year	3 years/1 year	3 years/1 year	3 years/3 years	3 years/3 years
On-site service charge	Included (1 year)	Included (1 year)	Included (1 year)	\$129.95 (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)

Blue Star Marketing Inc.

Eclipse E-133, Eclipse P-166

Blue Star Marketing's \$2,399 Eclipse E-133 is sold to home and corporate entry-level users. The higher-end, \$3,499 Eclipse P-166 targets corporate users who need faster performance. Although the company's prices are attractive, the units' benchmark test results were mixed. Blue Star also offers entry-level home PCs as part of the E-series and markets the Internet Workstation line with Netscape.

The two machines use Tyan motherboards with Intel Triton chip sets. Each has pipelined-burst secondary processor cache, 256K in the E-133 and 512K in the P-166. The E-133 posted an average Winstone 96 result but a below-average Winstone 32 score. The P-166's scores were average on both Winstone tests, but the unit garnered below-average scores on our two CPUmark tests.

The E-133 used a 1GB Fast ATA-2 hard disk, which contributed to the system's below-average Disk WinMark 96 score. The 2GB Fast SCSI-2 7,200-rpm

hard disk in the P-166 allowed that model to reach a high score within the average range for its 166-MHz class on our Disk WinMark test. The machines used Diamond Stealth64 Video VRAM 3240 graphics cards, which helped them attain average Graphics WinMark 96 scores for their respective classes. Both systems, however, were hampered by 6X Acer CD-ROM drives with relatively slow access times, and they turned in below-average CD-ROM WinMark 96 scores.



Blue Star P-166

Both Blue Star models came with 15-inch Viewsonic monitors and Creative Labs Sound Blaster AWE32 FM audio cards capable of wavetable synthesis. No modem is included with either system nor is there any application software bundled with either machine.

Blue Star covers the units with a one-year warranty that can be extended to five years for \$100. One year of on-site service costs \$49.—**BB Eclipse E-133.** Direct price: \$2,399. **Eclipse P-166.** Direct price: \$3,499. Blue Star Marketing Inc., Minneapolis, MN; 800-950-8884, 612-788-5000; fax, 612-788-3442; <http://www.blue-star.com> *Circle 446 on reader service card.*

CompuTrend System Inc.

Premio Triton P133, Premio Triton P166

CompuTrend's \$1,899 Premio Triton P133—one of the lowest-priced systems in this roundup—is a midrange desktop PC; the \$3,599 Premio Triton P166 tower system is meant for more demanding applications. Both are sold to VARs for resale under the CompuTrend name to small and midsize businesses. Both units performed well on all of our benchmark tests. CompuTrend also has a value line called the P series, which is sold to business users on budgets who don't mind giving up extra performance.

Both Premio systems are based on the company's Premio 200A motherboard, with the Intel Triton chip set, 256K pipelined-burst secondary processor cache, and EDO DRAM. The P133 system comes with a Quantum Fireball 1.2GB Fast ATA-2 hard disk, an ATI Xpression graphics card with 2MB of DRAM, and a 15-inch CompuTrend monitor. On our tests, the P133 posted average Winstone 96, Winstone 32 and Disk WinMark 96 scores for its 133-MHz CPU class, and above-average Graphics WinMark 96 results.

The P166 system posted average test

Austin PowerPlus 166	Blue Star Eclipse E-133	Blue Star Eclipse P-166	CompuTrend Premio Triton P133	CompuTrend Premio Triton P166	Comtrade Hyperspeed Multimedia	Comtrade Wide SCSI Powerstation	CSS Preferred MT 5/133	CSS Preferred MT 5/166	Data Storage DataStor P5-133
\$3,999 (direct)	\$2,399 (direct)	\$3,499 (street)	\$1,899 (street)	\$3,599 (street)	\$2,145 (direct)	\$3,625 (direct)	\$2,806 (street)	\$3,637 (street)	\$2,095 (direct)
Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/133
16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Seagate ST32550W	Seagate ST51080A	Seagate ST32550N	Quantum Fireball 1280A	Quantum Atlas XP32150W	Quantum Fireball 1280A	Quantum Atlas XP34300W	Quantum Fireball 1280A	Quantum Atlas XP32150W	Seagate ST51080A
2GB Fast/Wide SCSI-2	1GB Fast ATA-2	2GB Fast SCSI-2	1.2GB Fast ATA-2	2GB Fast/Wide SCSI-2	1.2GB Fast ATA-2	4GB Fast/Wide SCSI-2	1.2GB Fast ATA-2	2GB Fast/Wide SCSI-2	1GB Fast ATA-2
Video Logic GraphicsStar 400	Diamond Stealth64 Video VRAM 3240	Diamond Stealth64 Video VRAM 3240	ATI Video Xpression	Number Nine Imagine 128	Diamond Stealth64 Video 2121	Diamond Stealth64 Video 2121	Matrox MGA Millennium	Matrox MGA Millennium	STB Powergraph 64 Video
2MB DRAM	2MB VRAM	2MB VRAM	2MB DRAM	4MB VRAM	2MB EDO DRAM	2MB EDO DRAM	2MB WRAM	4MB WRAM	1MB EDO DRAM
Smile CB1716SL (16, 17)	ViewSonic 15GA (14, 15)	ViewSonic 15GA (14, 15)	CompuTrend F562DU (13.7, 15)	CompuTrend Q766DU (16, 17)	MAG InnoVision DX1595 (14, 15)	MAG InnoVision DX1795 (16, 17)	Sceptre CC-615GL+ (14.8, 15)	Sceptre CC-615GL+ (14.8, 15)	Vertos 1502 (13.8, 15)
TEAC (6X)	Acer (6X)	Acer (6X)	TEAC (6X)	TEAC (6X)	Hitachi (6X)	Hitachi (6X)	Toshiba (6X)	Toshiba (6X)	Torisan (4X)
Crystal Lake Multimedia 220	Sound Blaster AWE32	Sound Blaster AWE32	Behavior Tech Computer 1831	Behavior Tech Computer 1831	Diamond Sonic Sound LX	Diamond Sonic Sound LX	Sound Blaster 16	Sound Blaster 16	Turtle Beach
Audiophile MM-10	None	None	MIDI Land ML-691H	MIDI Land ML-691H	QuickShot QS-829	QuickShot Sound Force 600	JUSTer JDC-691	JUSTer JDC-691	FLY PC60
512K	256K	512K	256K	256K	256K	512K	256K	512K	256K
Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
Intel	Tyan	Tyan	CompuTrend	CompuTrend	Tyan	Expert	CSS	CSS	Elitgroup
Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX
3 years/3 years	1 year/1 year	1 year/1 year	3 years/2 years	3 years/2 years	1 year/1 year	1 year/1 year	3 years/1 year	3 years/1 year	3 years/3 years
Included (1 year)	\$49 (1 year)	\$49 (1 year)	\$229 (4 years)	\$229 (4 years)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	\$75 per year

scores for its 166-MHz class on both Winstone tests, as well as our Disk WinMark and Graphics WinMark tests. It included a Quantum Atlas 2GB 7,200-rpm Fast/Wide SCSI-2 hard disk with an

Adaptec controller, a Number Nine Imagine 128 graphics card with 4MB of VRAM, and a 17-inch CompuTrend monitor.

Both models came with a TEAC 6X CD-ROM drive and garnered above-average CD-ROM

WinMark 96 scores. Each also included a Behavior Tech FM synthesis audio card, MLI 691H speakers and Novell Perfect Office 3.0.

CompuTrend provides its two units with a three-year-parts, two-year-labor warranty; four years of parts and labor costs a total of \$229.—BB

Premio Triton P133. Street price: \$1,899. **Premio Triton P166.** Street price: \$3,599. CompuTrend Systems Inc., City of Industry, CA; 800-677-6477, 818-333-5121; fax, 818-369-6803; <http://www.premiopc.com>. Circle 447 on reader service card.

Comtrade Hyperspeed Multimedia, Wide SCSI Powerstation

You can look to either the Hyperspeed Multimedia or the Wide SCSI Powerstation from Comtrade for a PC with solid performance and a good price. The \$2,145 Pentium 133-MHz Hyperspeed Multimedia is suited for small or midsize business needs, and the \$3,625 166-MHz Wide SCSI Powerstation is geared for more demanding corporate or CAD business applications.

The Hyperspeed Multimedia used a Tyan motherboard with the Intel Triton chip set and was outfitted with 256K of pipelined-burst secondary processor cache, a Quantum Fireball 1.2GB Fast ATA-2 hard disk and a Diamond Stealth64 Video 2121 graphics card with 2MB of EDO DRAM. These components helped the Multi-

media bring in average scores on both of our Winstone tests and on our Disk WinMark 96 test. The Diamond Stealth card came through on our Graphics WinMark 96 test, helping the unit earn an above-average result.

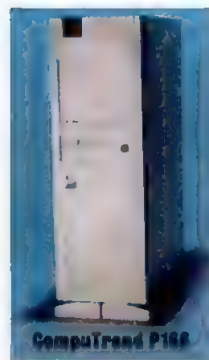
The Powerstation system, using a Triton-based Expert motherboard, came with 512K of pipelined-burst L2 cache, a 4GB Quantum Atlas Fast/Wide SCSI-2 7,200-rpm hard disk, and the same graphics card as the Multimedia. It posted average scores on the two Winstone tests and the Graphics WinMark test; its Disk WinMark score was among the best of all units tested. Both PCs came with a 6X CD-ROM drive and posted average scores on our CD-ROM WinMark 96 test.

The two units included MAG Inno-

Vision monitors—a 15-inch model for the Multimedia and a 17-inch model for the Powerstation. Both also came with 16-bit Diamond Sonic Sound LX audio cards, Supra Express 28.8-Kbps data/fax modems and Novell Perfect Office 3.0.

These Comtrade units are covered by a one-year parts-and-labor warranty, with on-site service included.—BB

Hyperspeed Multimedia. Direct price: \$2,145. **Wide SCSI Powerstation.** Direct price: \$3,625. Comtrade, City of Industry, CA; 800-969-2123, 818-961-6688; fax, 818-369-1479. Circle 448 on reader service card.



CompuTrend P166



Comtrade Wide SCSI

SUMMARY OF FEATURES

Pentium PCs

PC MAGAZINE
EDITOR'S CHOICE

■ YES ■ NO

Products listed in review order

	Data Storage DataStor P5-166	Dell Dimension XPS P133c	Dell Dimension XPS P166s	Dell OptiPlex GXMT 5133	Dell OptiPlex GXMT 5166	Diamond Office Mate 133	Diamond Office Intelligent 166	Digital Celebris GL 5166ST
Price of tested configuration	\$2,345 (direct)	\$2,379 (direct)	\$3,349 (direct)	\$2,965 (direct)	\$4,624 (direct)	\$2,295 (direct)	\$4,295 (direct)	\$4,978 (list)
Processor	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/166
Installed RAM	16MB EDO	16MB EDO	16MB SDRAM	16MB EDO	16MB EDO	16MB	16MB EDO	16MB EDO
Hard disk manufacturer and model	Seagate ST51080A	Quantum Fireball 1080A	Quantum Fireball 1080A	Western Digital Caviar AC31600	Seagate ST32140A	Western Digital Caviar AC31600	Seagate ST32550N	Quantum Fireball 1280A
Capacity and interface	1GB Fast ATA-2	1GB Fast ATA-2	1GB Fast ATA-2	1.5GB EIDE	2GB Fast ATA-2	1.5GB EIDE	2GB Fast SCSI-2	1.2GB Fast ATA-2
Graphics adapter	STB Powergraph 64 Video	Number Nine Motion 771	Number Nine Imagine 128 Series 2	Integrated (S3 Trio64V+)	Number Nine Imagine 128	Diamond Stealth64 Video VRAM 3240	Number Nine Imagine128	Matrox MGA Millennium
Memory	1MB EDO DRAM	2MB VRAM	4MB VRAM	2MB DRAM	4MB VRAM	2MB VRAM	4MB VRAM	2MB VRAM
Monitor (and screen diagonal measured/claimed, in inches)	Vertos 1502 (13.8, 15)	Dell D1528-LS (13.7, 15)	Dell D1728D-LS (15.5, 17)	Dell D1528-LS (13.7, 15)	Dell VS17X (15.5, 17)	MAG InnoVision DX1595 (14, 15)	MAG InnoVision DX1795 (16, 17)	Digital PCXCV-AC (13.5, 15)
CD-ROM drive (speed)	Torisan (4X)	TEAC (6X)	TEAC (6X)	NEC (4X)	NEC (4X)	TEAC (6X)	Toshiba (6.7X)	Mitsumi (4X)
Sound adapter	Turtle Beach	Sound Blaster 16 Value	Integrated (Vibra 16S)	Integrated (Vibra 16S)	Integrated (Vibra 16S)	Diamond WaveStar 32	Diamond WaveStar 32	Integrated (ESS 1688)
Speakers	FLY PC80	Altec Lansing ACS5	Altec Lansing ACS31	Altec Lansing ACS5	Altec Lansing ACS31	MIDI Land MLI- 691H	JUSTer SP-690	Labtec LCS-800
Installed external RAM cache	256K	256K	512K	256K	512K	512K	512K	512K
Type of cache	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
Motherboard manufacturer	Elitegroup	Intel	Intel	Dell	Dell	ASUSTeK	ASUSTeK	Digital
Chip set manufacturer	Intel 430FX	Intel 430FX	Intel 430VX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX
Standard warranty on parts/labor	3 years/3 years	3 years/1 year	3 years/1 year	3 years/1 year	3 years/1 year	1 year/1 year	1 year/1 year	3 years/3 years
On-site service charge	\$75 per year	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)

CSS Laboratories Inc.

Preferred MT 5/133, Preferred MT 5/166

CSS Laboratories' two PCs deliver good performance value for the money. The \$2,806 Preferred MT 5/133, a 133-MHz Pentium system, is an entry-level PC for home and small business users; the \$3,637 MT 5/166 is a 166-MHz Pentium system with a SCSI hard disk and is intended for high-end corporate users who work with graphics applications. Both systems were consistently above-average performers.

CSS has been selling PCs since 1984, primarily to government buyers. The company has recently entered the commercial market, selling systems through value-added resellers to corporate customers.

Both mini-tower systems used CSS Triton 1 motherboards with Intel Triton chip sets, pipelined-burst secondary processor cache (256K on the CSS 5/133 and 512K on the CSS 5/166) and EDO DRAM. Both systems posted average Winstone 96 and Winstone 32 scores for their respective CPU classes.



The CSS 5/133 was equipped with a Quantum Fireball 1.2GB Fast ATA-2 hard disk and Matrox MGA Millennium graphics card with 2MB of WRAM. The CSS 5/166 had a Quantum Atlas 2GB Fast/Wide SCSI-2 7,200-rpm hard disk and a Matrox MGA Millennium card with 4MB of WRAM. The Matrox card helped the CSS 5/133 garner an above-average score on our Graphics WinMark 96 test. The units' Toshiba 6X CD-ROM drives performed well, helping them earn above-average scores in CD-ROM WinMark 96 testing. Other benchmark test scores were average for both systems.

The two CSS machines also included Creative Labs Sound Blaster 16 FM synthesis audio cards and Sceptre 15-inch monitors.

CSS backs these desktop systems with a three-year-parts, one-year-labor warranty, which also includes one year of on-site service.—BB

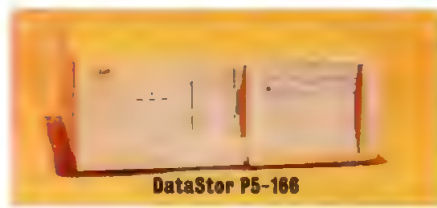
Preferred MT 5/133. Street price: \$2,806. **Preferred MT 5/166.** Street price: \$3,637. CSS Laboratories Inc., Irvine, CA; 800-486-9702, 714-852-8161; fax, 714-852-0410. Circle 449 on reader service card.

Data Storage Marketing Inc.

DataStor P5-133, DataStor P5-166

The DataStor line from Data Storage Marketing is sold as a low-cost solution for corporate buyers. At \$2,095 for the 133-MHz version and \$2,345 for the 166-MHz version (both prices direct), the company clearly offers appealing prices. Performance for both machines was mixed, however: They earned average to below-average scores on our benchmark tests. The DataStor P5-166 fared slightly better against its competition than the DataStor P5-133.

There were signs of quality in assembly—such as the use of silicon to hold cable connectors in place—but cost-cutting measures were also evident. Documentation was very thin, and the speakers included with the system were inexpensive, not self-powered, and produced poor sound. The bundled software was a curi-



DirectWave Blue Thunder PHX133MVP Pro	DirectWave Blue Thunder PH166MVP Pro	DTK QUIN- 55M/P166	EPS Evolution LP-133	EPS Evolution XLP-166	Everex Step Premier 133	Everex Step Premier 166	Everex Tempo Select 133	Everex Tempo Select 166	Gateway P5-133
\$2,549 (direct)	\$3,599 (direct)	\$3,270 (street)	\$2,295 (direct)	\$4,395 (direct)	\$2,749 (street)	\$4,749 (street)	\$2,499 (street)	\$3,399 (street)	\$2,414 (direct)
Pentium/133	Pentium/166	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/133
16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB BEDO	16MB BEDO	16MB EDO
Quantum Fireball 1280A	Quantum Atlas XP32150W	Quantum Fireball 1280A	Quantum Fireball 1280A	Quantum Atlas XP34300W	Quantum Fireball 1280A	Seagate ST32550W	Quantum Fireball 1280A	Quantum Fireball 1280A	Seagate ST32140A
1.2GB Fast ATA-2	2GB Fast/Wide SCSI-2	1.2GB Fast ATA-2	1.2GB Fast ATA-2	4GB Fast/Wide SCSI-2	1.2GB Fast ATA-2	2GB Fast/Wide SCSI-2	1.2GB Fast ATA-2	1.2GB Fast ATA-2	2GB Fast ATA-2
Matrox MGA Millennium	Matrox MGA Millennium	Number Nine Imagine 128	Number Nine Motion 771	Number Nine Imagine 128	Matrox MGA Millennium	Matrox MGA Millennium	Matrox MGA Millennium	Matrox MGA Millennium	Matrox MGA Millennium
2MB WRAM	4MB WRAM	4MB VRAM	2MB VRAM	4MB VRAM	2MB WRAM	4MB WRAM	2MB WRAM	4MB WRAM	2MB WRAM
MAG InnoVision DX1595 (14, 15)	MAG InnoVision DX1595 (14, 15)	Tatung TD- 15NLGS (13.5, 15)	CTX 1765GMe (16, 17)	CTX 1785XA (16, 17)	TVM AS5G (14, 15)	Shamrock SRC 1702 LD (15.8, 17)	TVM AS5G (14, 15)	Shamrock SRC1703 (16, 17)	Sony Vivitron (16, 17)
TEAC (6X)	TEAC (6X)	TEAC (6X)	Hitachi (6X)	Hitachi (6X)	Toshiba (6X)	Toshiba (6X)	Toshiba (6X)	Toshiba (6X)	Torisan (4X)
Sound Blaster AWE32 PnP	Sound Blaster AWE32	Sound Blaster Value 16	Ensoniq Soundscape	Ensoniq Soundscape	Sound Blaster AWE32 Value	Sound Blaster AWE32 PnP	Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster 16
Conch SK-A30	Conch SK-A30	Lasonic TVS-170	Labtec LCS-3210	Labtec LCS- 3211/2410	Labtec LCS-600	Yamaha YST- M10	Labtec LCS-600	Yamaha YST- M10	Altec Lansing ACS40
512K	512K	512K	256K	512K	256K	512K	512K	512K	256K
Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
ASUSTeK	ASUSTeK	DTK	First International	First International	First International	First International	First International	First International	Intel
Intel 430HX	Intel 430HX	Intel 430HX	Intel 430FX	Intel 430FX	Intel 430HX	Intel 430HX	VIA VT82C580	VIA VT82C580	Intel 430FX
4 years/4 years	4 years/4 years	2 years/2 years	3 years/3 years	3 years/3 years	5 years/5 years	5 years/5 years	3 years/3 years	3 years/3 years	3 years/1 year
Included (4 years)	Included (4 years)	\$50 (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)

ous mix for a system intended for corporate use, with shareware games, Internet software, and a multimedia encyclopedia.

Benchmark test results ranged from average to below average for both PCs. On our Winstone measures, the DataStor P5-166 posted average scores on both Winstone 96 and Winstone 32 tests, while the DataStor P5-133 garnered an average score on the Winstone 32 test and a below-average Winstone 96 score. These units produced below-average Graphics WinMark 96 scores, mainly because of their STB Powergraph 64 graphics boards, with only 1MB of EDO DRAM. Both were also below par on the CD-ROM WinMark 96 test. This was most likely because of their Torisan 4X CD-ROM drives, hampered by slow access times of 250 ms, and competing in a field with many 6X drives. Both units had average Disk WinMark 96 scores within their respective classes.

Data Storage Marketing covers the units for parts and labor for three years. On-site service is an additional \$75 per year.—*Alfred Poor*

DataStor P5-133. Direct price: \$2,095. **DataStor P5-166.** Direct price: \$2,345. Data Storage Marketing Inc., Boulder, CO; 800-543-6098, 303-442-4747; fax, 303-442-7985. Circle 450 on reader service card.

Dell Computer Corp.

Dimension XPS P133c, Dimension XPS P166s, OptiPlex GXMT 5133, OptiPlex GXMT 5166



Strong components and solid performance at reasonable prices make Dell systems attractive choices—for different audiences. The OptiPlex GXMT line (\$2,965 direct for the 133-MHz model, \$4,624 for the 166-MHz model), intended for corporate installations, is DMI compliant and comes with an integrated 3Com 10-Mbps Ethernet adapter. The Dimension XPS series (\$2,379 direct for the 133-MHz model, \$3,349 direct for the 166-MHz version) provides better performance and is intended for small- and home-office buyers. The Dimension XPS P133c is one of our Editors' Choices in this roundup; it provides a great all-around package at a reasonable price.

Both 166-MHz PCs included 512K of pipelined-burst cache and 17-inch

monitors. The 133-MHz PCs had 256K of L2 cache and 15-inch displays. All four Dells came with Altec Lansing speakers.

The OptiPlex PCs performance generally placed them in the middle of the pack. Using 4X CD-ROM drives, both garnered below-average CD-ROM WinMark 96 scores, however. The OptiPlex 5133, using an integrated S3 Trio64V+ chip set, also posted a below-average Graphics WinMark 96 score. Both OptiPlexes have limited space for expansion, offering only two PCI slots.

The Dimension machines both performed well on our benchmark tests. The Dimension P166s's performance highlight was on our Graphics WinMark tests. It garnered the second-highest score of this roundup, thanks to its Number Nine Imagine 128 Series 2 graphics accelerator card. The system was also the only unit in this roundup to use synchronous DRAM for main memory.

The Dimension P133c shone on the CD-ROM WinMark test, earning an above-average score. Both Dimension units posted average scores on all other tests. They

SERVICE & RELIABILITY

Dell Computer Corp.

Reliability	Better than average
Repair	Better than average
Technical support	Better than average
Percent needing repair	Average

SUMMARY OF FEATURES

Pentium PCs

■ YES ■ NO

Products listed in review order

	Gateway PS-166	SST Aspegos P133	SST Aspegos P166	HD Victoria P-120	HD Victoria P-166	Hertz Z-Pent P133a	Hertz Z-Pent P166a	HP Vectra XM Series 4 5/120
Price of tested configuration	\$3,609 (direct)	\$2,495 (direct)	\$2,729 (direct)	\$2,495 (direct)	\$3,395 (direct)	\$2,175 (direct)	\$3,395 (direct)	\$2,815 (street)
Processor	Pentium/166	Pentium/133	Pentium/166	Pentium/120	Pentium/166	Pentium/133	Pentium/166	Pentium/120
Installed RAM	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Hard disk manufacturer and model	IBM DORS-32180	Quantum Fireball 1280A	Quantum Fireball 1280A	Western Digital Caviar AC31600	Western Digital Caviar AC31600	Seagate ST51080A	Seagate ST32550W	Quantum Fireball 1280A
Capacity and interface	2GB Fast SCSI-2	1.2GB Fast ATA-2	1.2GB Fast ATA-2	1.5GB EIDE	1.5GB EIDE	1GB Fast ATA-2	2GB Fast/Wide SCSI-2	1.2GB Fast ATA-2
Graphics adapter	Matrox MGA Millennium	Number Nine Imagine 128	Number Nine Imagine 128	Number Nine Motion 771	Matrox MGA Millennium	ATI Winturbo	ATI Winturbo	Integrated (S3 Trio64V+)
Memory	2MB VRAM	4MB VRAM	4MB VRAM	2MB VRAM	2MB VRAM	2MB VRAM	2MB VRAM	2MB DRAM
Monitor (and screen diagonal measured/claimed, in inches)	Sony Vivitron CPD 17F23 (16, 17)	Proton GM-1764M (16, 17)	Proton GM-1764M (16, 17)	MAG InnoVision DX1595 (14, 15)	Iiyama MT-9017E (16, 17)	MAG InnoVision DX17F (16, 17)	MAG InnoVision DX17F (16, 17)	Hewlett-Packard D2808B (13.8, 15)
CD-ROM drive (speed)	Torisan (4X)	TEAC (6X)	TEAC (6X)	TEAC (6X)	TEAC (8X)	Toshiba (4X)	Toshiba (6.7X)	None
Sound adapter	Sound Blaster 16	Sound Blaster AWE32	Sound Blaster AWE32	Integrated (Vibra 16S)	Integrated (Vibra 16S)	Sound Blaster 16	Sound Blaster 16	None
Speakers	Altac Lansing ACS40	None	None	JUStEr SP-935	Yamaha YST-M10	MIDI Land MLI-891H	MIDI Land MLI-891H	None
Installed external RAM cache	512K	512K	512K	256K	256K	512K	512K	256K
Type of cache	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
Motherboard manufacturer	Intel	ASUSTeK	ASUSTeK	Intel	Intel	Hertz	Hertz	Hewlett-Packard
Chip set manufacturer	Intel 430FX	Intel 430FX	Intel 430HX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX
Standard warranty on parts/labor	3 years/1 year	1 year/1 year	1 year/1 year	1 year/1 year	1 year/1 year	1 year/1 year	1 year/1 year	3 years/3 years
On-site service charge	Included (1 year)	\$69 (2 years)	\$69 (2 years)	\$75 (1 year)	\$75 (1 year)	\$495 (1 year)	\$495 (1 year)	Included (1 year)

also came equipped with 1GB Quantum Fireball hard disks, 6X CD-ROM drives, and Microsoft Office Professional and Bookshelf for Windows 95.

The Dell PCs have a one-year parts-and-labor, on-site warranty, followed by two years of next-day replacement-part delivery. Toll-free technical support is available 24 hours a day, 7 days a week.—AP

Dimension XPS P133c. Direct price, \$2,379. **Dimension XPS P166s.** Direct price, \$3,349. **OptiPlex GXMT 5133.** Direct price: \$2,965. **OptiPlex GXMT 5166.** Direct price: \$4,624. Dell Computer Corp., Austin, TX; 800-289-3355, 512-338-4400; fax, 800-727-8320; <http://www.dell.com>. **Circle 451 on reader service card.**

Diamond Technologies Inc.

Office Mate 133, Office Intelligent 166

With its two lines, Diamond Technologies gives you a choice of low price or above-

average performance. The Pentium 133-based Office Mate 133 (\$2,295 direct) is a cost-conscious choice aimed at buyers who want midrange performance for general office use. The 166-MHz Office Intelligent 166 (\$4,295 direct) has a number of upgraded components, designed to provide above-average performance for business power users.

The Office Mate has some attractive components, such as a TEAC 6X CD-ROM drive and a 14.4-Kbps data/fax/voice modem. The system also included a 15-inch MAG InnoVision monitor. The unit garnered average results on most of our tests, except for its below-average Graphics WinMark 96 score. The only above-average results were the unit's scores on our CD-ROM tests, where the TEAC drive no doubt helped.

For performance, the Office Intelligent model is the way to go. Our test system came with 512K of pipelined-burst L2 cache, and a 7,200-rpm Seagate ST 32550N Fast SCSI-2 hard disk with an Adaptec PCI controller. A Number Nine Imagine 128 graphics adapter with 4MB of VRAM and a 28.8/14.4-Kbps data/fax modem complete the hardware package.

Thanks to a Toshiba 6.7X CD-ROM drive, the Office Intelligent was a fast

performer on our CD-ROM tests, and the Seagate hard disk helped the unit turn in average Disk WinMark 96 scores. Performance on both Winstone tests and our graphics tests was average.

Diamond Technologies backs its systems with a one-year, on-site parts-and-labor warranty.—AP

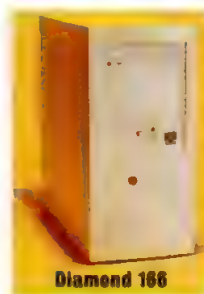
Office Mate 133. Direct price: \$2,295. **Office Intelligent 166.** Direct price: \$4,295.

Diamond Technologies Inc., Anaheim, CA; 800-989-7253, 714-533-9910; fax, 714-533-7805; <http://www.diamondtech.com>. **Circle 452 on reader service card.**

Digital Equipment Corp.

Celebris GL 5166ST

Digital Equipment Corp.'s \$4,978 Celebris GL 5166ST mini-tower system offers easy setup and network integration, plus competitive performance. The Pentium-based, DMI-compliant Celebris GLs—featuring a 15-inch Digital monitor and a 115.2-Kbps IrDA-compliant infrared interface—are targeted at corporate power



HP Vectra VL Series 4 5/133	HP Vectra 500 Model 515MCx 5/166	HP Vectra VL Series 4 5/166 MT	HiQuality HIQ P133 Mars Station	HiQuality HIQ P166 Mars Station	IBM PC 350 P133	IBM PC 350 P166	Maximus Magna Media P/133	Maximus Magna Graphics P/166	Maximus Magna SCSI Media P/166
\$3,285 (street)	\$3,430 (street)	\$3,925 (street)	\$2,765 (direct)	\$3,999 (direct)	\$3,484 (list)	\$4,258 (list)	\$2,399 (direct)	\$3,199 (direct)	\$5,399 (direct)
Pentium/133	Pentium/166	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/166
16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Quantum Fireball 1080A	Western Digital Caviar AC31600	Quantum Fireball 1080A	Quantum Fireball 1280A	Quantum Grand Prix XP34301S	Quantum Fireball 1280A	Quantum Fireball 1280A	Quantum Fireball 1280A	Seagate ST3250W	Seagate ST3250W
1GB Fast ATA-2	1.5GB EIDE	1GB Fast ATA-2	1.2GB Fast ATA-2	2GB Ultra SCSI	1.2GB Fast ATA-2	1.2GB Fast ATA-2	1.2GB Fast ATA-2	2GB Fast ATA-2	2GB Fast/Wide SCSI-2
Matrox MGA Millennium	Integrated (S3 Trio64V+)	Matrox MGA Millennium	Number Nine Imagine 128	Number Nine Imagine 128	Matrox MGA Millennium	Matrox MGA Millennium	Matrox MGA Millennium	Matrox MGA Millennium	Matrox MGA Millennium
2MB VRAM	1MB DRAM	2MB VRAM	2MB VRAM	2MB VRAM	4MB VRAM	4MB VRAM	2MB VRAM	2MB VRAM	4MB VRAM
Hewlett-Packard D2806B (13.5, 15)	Hewlett-Packard D2808 (13.5, 15)	Hewlett-Packard D2808S (13.5, 15)	Princeton Ultra 17 (16, 17)	Princeton Ultra 17 (16, 17)	IBM P70 (16, 17)	IBM P70 (16, 17)	MAG InnoVision DX1595 (14, 15)	MAG InnoVision DX1795 (16, 17)	MAG InnoVision DX1795 (16, 17)
Sony (4X)	Hitachi (6X)	Sony (4X)	TEAC (6X)	TEAC (6X)	TEAC (6X)	TEAC (6X)	TEAC (6X)	Toshiba (6X)	Plextor (6X)
Sound Blaster 16	Sound Blaster 16	Sound Blaster 16	Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster AWE32
None	None	None	Yamaha YST-M5/MSW10	Yamaha YST-M5/MSW10	IBM	IBM	JUSTer SP-980	JUSTer SP-980	Jazz J-902/J330
256K	256K	256K	512K	512K	256K	256K	512K	512K	512K
Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
Hewlett-Packard Intel 430FX	Hewlett-Packard Intel 430FX	Hewlett-Packard Intel 430FX	ASUSTeK Intel 430HX	ASUSTeK Intel 430HX	Intel 430FX	Intel 430FX	Tyan Intel 430FX	Super Micro Intel 430FX	Quick Technology Intel 430FX
3 years/3 years	1 year/1 year	3 years/3 years	1 year/2 years	1 year/2 years	3 years/3 years	3 years/3 years	4 years/4 years	4 years/4 years	4 years/4 years
Included (1 year)	Included (1 year)	Included (1 year)	\$79.95 (2 years)	\$92.95 (2 years)	Included (3 years)	Included (3 years)	Included (4 years)	Included (4 years)	Included (4 years)

users and priced accordingly. Digital also markets two other lines: the Venturis line of Pentium-based, general-purpose, corporate machines and the Celebris XL line of Windows NT workstations, configured with Pentium, Pentium Pro, or Digital Alpha processors; Pentium models offer a dual-processor option.

Since Digital bundles its ClientWorks software and a Getting Started package with the system, configuring the Celebris GL and hooking it up to your Ethernet network is a breeze.

The system's ports are well labeled on an easily accessible, tool-free chassis, and the Intel Triton-based motherboard features an integrated 10-Mbps DECchip Ethernet controller, and a 16-bit audio chip set. Once up and running, you'll have easy access to both the Internet and .PDF file formats with the included copies of Netscape Navigator and Adobe Acrobat Reader.



On our benchmark tests, the Celebris GL kept pace with its 166-MHz competition. Configured with 512K of pipelined-burst secondary processor cache, EDO DRAM, and a 1.2GB Quantum Fireball hard disk, it posted average Winstone 96, Winstone 32, and Disk WinMark 96 scores.

The unit's on-board Matrox MGA Millennium graphics accelerator with 2MB of VRAM contributed to an average Graphics WinMark 96 score. The Celebris GL's Mitsumi 4X CD-ROM drive, playing in a field dominated by 6X CD-ROM drives, however, held the unit to a below-average CD-ROM WinMark 96 score. By the time you read this, these systems will be shipping with 8X CD-ROM drives.

The Celebris GL line is backed by a three-year parts-and-labor warranty, which include on-site service for the first year. Digital also provides toll-free 24-hour, 7-day live telephone technical support for its machines.—CM

Celebris GL 5166ST. List price: \$4,978. Digital Equipment Corp., Maynard, MA; 800-344-4825, 508-493-5111; fax, 508-480-8583; <http://www.pc.digital.com>. Circle 453 on reader service card.

DirectWave Inc.

Blue Thunder PHX133MVP Pro, Blue Thunder PH166MVP Pro

The DirectWave systems are great values given their strong performance and exceptional four-year warranties. The Blue Thunder PHX133MVP Pro (\$2,549 direct) is intended for midrange business and home users; the Blue Thunder PH166MVP Pro (\$3,599 direct) provides more processing power and is intended for use as a Windows NT workstation or with high-end applications such as multimedia authoring.

Both systems come with top-notch components, including a 28.8/14.4-Kbps data/fax modem (33.6/14.4-Kbps modems will be standard by the time you read this) and a keyboard with Windows 95 hotkeys. A Matrox MGA Millennium graphics adapter (with 4MB of VRAM on the 166MVP and 2MB on the 133MVP) provides strong display support, and the TEAC 6X CD-ROM drive accelerates data access. Each PC includes Lotus SmartSuite, a microphone, and headphones. Each also uses 512K of pipelined-burst L2 cache and has a 15-inch MAG monitor.

SERVICE & RELIABILITY

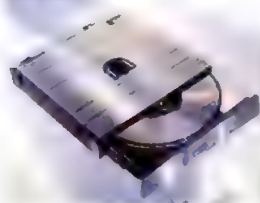
Digital Equipment Corp.

Reliability	Better than average
Repair	Better than average
Technical support	Better than average
Percent needing repair	Better than average

Designed for

Microsoft
Windows 95

**THERE ARE
TIMES WHEN
YOU NEED
THE MOST
ADVANCED
MULTIMEDIA
NOTEBOOK
ON THE
MARKET.**

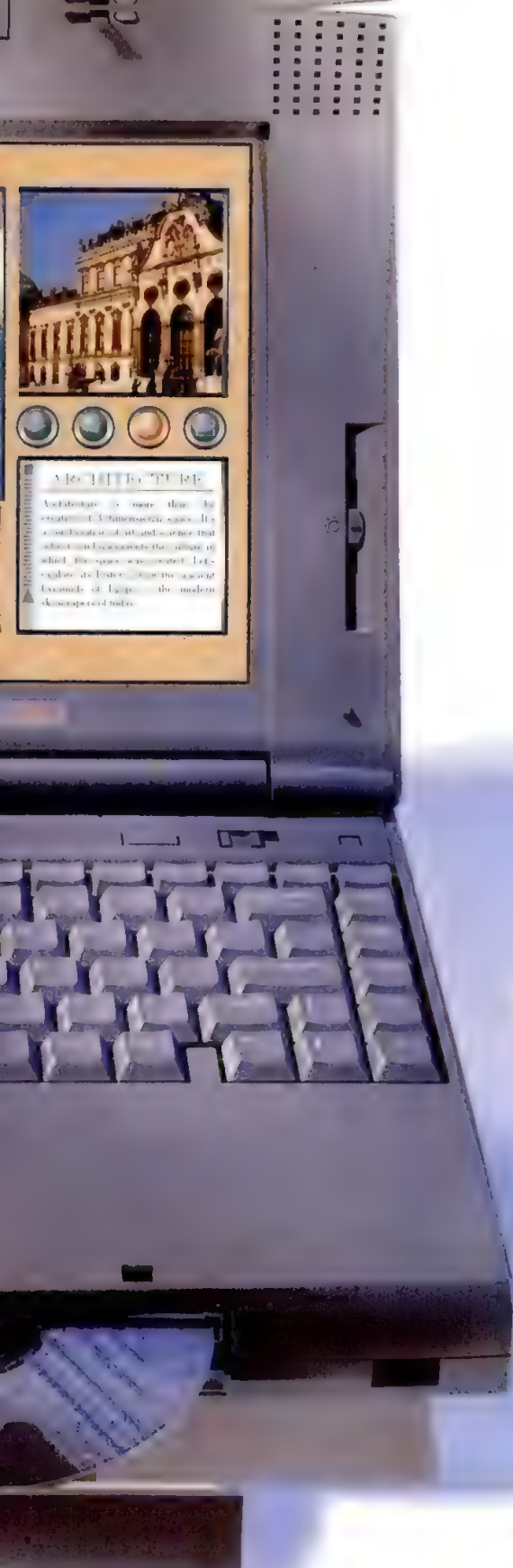


VersaBay™ II technology
lets you configure the
Versa® 4000 at a moment's
notice. Need multimedia?
Slip in the CD-ROM.

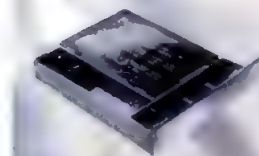


*The Versa 4000 is available in a variety of configurations with 75, 90 and 120MHz Pentium processors. For information via fax, call NEC FastFacts™ at 1-800-466-0376 or look us up at <http://www.nec.com>. Versa is a registered U.S. trademark. VersaBay, VersaGlide, FastFacts, and See, Hear and Feel the Difference are trademarks of NEC Technologies, Inc. The Intel Inside logo and Pentium are registered trademarks of Intel Corp. The Designed for Windows 95 logo and Windows 95 are trademarks of Microsoft Corp. User may choose one of two preinstalled operating systems: Windows 95 or Windows for Workgroups 3.11. All other trademarks are properties of their respective owners. ©1995 NEC Technologies, Inc. NEC USA #GSOOK91AGS52A1PS01.

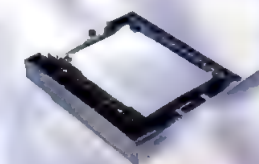
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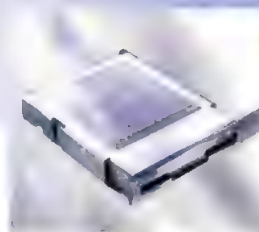
**AND TIMES WHEN
YOU DON'T.**



For more power, slide in a second state-of-the-art lithium-ion battery.



Want additional storage? Snap in a second hard drive.



For software installation, insert the 1.44MB floppy disk drive.

Introducing the NEC Versa® 4000.

Along with the innovative VersaBay II, the Versa 4000 features a 10.4" high-resolution screen, full-motion video support, SoundBlaster® Pro compatibility, two built-in speakers and a microphone. So what do you get when you combine all that with its 120MHz Pentium® processor*, 1GB hard drive, 8 - 40MB RAM, a lithium-ion battery, a VersaGlide™ pointing device and hot-swappable PC Cards? Simple. Not just the most advanced notebook for multimedia, the most advanced notebook, period. Call 1-800-NEC-VERSA.

SEE, HEAR

AND FEEL THE

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NEC

SUMMARY OF FEATURES

Pentium PCs

■ YES ■ NO

Products listed in review order

	Mega Impact 5133PC160	Mega Impact 5166PC16MT	Memorex Telux Celerria Mini Tower	Micro Express MicroFlex- 006/P166+	Micron Millennia 133	Micron Millennia 166	Micron Millennia Plus	MidWest Micro P5-133 Office PC
Price of tested configuration	\$2,075 (direct)	\$2,900 (direct)	\$2,295 (direct)	\$2,399 (direct)	\$3,148 (direct)	\$3,517 (direct)	\$5,405 (direct)	\$2,499 (direct)
Processor	Pentium/133	Pentium/166	Pentium/133	Cyrix 6x86-P166+	Pentium/133	Pentium/166	Pentium/166	Pentium/133
Installed RAM	16MB EDO	16MB EDO	16MB	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Hard disk manufacturer and model	Western Digital Caviar AC21200	Quantum Atlas XP32150S	Western Digital Caviar AC31200	Quantum Fireball 1280A	Quantum Fireball 1280A	Quantum Fireball 1280A	Conner CFP2107W	Western Digital Caviar AC31600
Capacity and interface	1.2GB EIDE	2GB Fast SCSI-2	1.2GB EIDE	1.2GB Fast ATA-2	1.2GB Fast ATA-2	1.2GB Fast ATA-2	2GB Fast/Wide SCSI-2	1.5GB EIDE
Graphics adapter	Diamond Stealth64 Video 2201	Diamond Stealth64 Video 2201	ATI Graphics Xpression	Matrox MGA Millennium	Number Nine Imagine 128 Series 2	Number Nine Imagine 128 Series 2	Number Nine Imagine 128 Series 2	Number Nine Motion 771
Memory	2MB EDO DRAM	2MB EDO DRAM	2MB DRAM	2MB VRAM	4MB VRAM	4MB VRAM	4MB VRAM	2MB VRAM
Monitor (and screen diagonal measured/claimed, in inches)	MGC DCM-158BE (14, 15)	MGC DCM-168BE (14, 15)	Philips 1215DC (14, 15)	GVC Tech Inc. M156BL (14, 15)	MAG InnoVision DX1795 (16, 17)	MAG InnoVision DX1795 (16, 17)	MAG InnoVision DX1795 (16, 17)	Infotek SRC- 1502LD (14, 15)
CD-ROM drive (speed)	Toshiba (6X)	Toshiba (6X)	Pioneer (4X)	Sony (4X)	Sanyo (6X)	Hitachi (8X)	Plextor (9X)	Acer (6X)
Sound adapter	Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster 16	Sound Blaster 16	Sound Blaster 16	Sound Blaster AWE32, PnP	Sound Blaster AWE32, PnP	Aztech Wavemaster 3D
Speakers	Kingtex EP-120A	Kingtex EP-120A	Koss PCM/235	MIDI Land MLI-125	Advent AV270	Advent AV270	Advent AV370	Labtec LCS-1022
Installed external RAM cache	256K	256K	256K	512K	256K	256K	256K	256K
Type of cache	Pipelined-burst	Pipelined-burst	Asynchronous	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
Motherboard manufacturer	BCM	BCM	BCM	Tyan	Intel-OPSO	Intel-OPSO	Intel-OPSO	ASUSTek
Chip set manufacturer	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430HX	Intel 430HX	Intel 430HX	Intel 430FX
Standard warranty on parts/labor	2 years/1 year	2 years/1 year	1 year/1 year	2 years/2 years	3 years/1 year	3 years/1 year	3 years/1 year	3 years/3 years
On-site service charge	N/A	N/A	Included	\$50 (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	N/A

N/A—Not applicable. The product does not have this feature.

There are some component differences. The 166-MHz unit uses a Triton II-based ASUStek motherboard, while the 133-MHz model uses a Triton I ASUStek motherboard. Hard disks are also different: The 166MVP features a 2GB Fast/Wide SCSI-2 7,200-rpm hard disk with a BusLogic PCI controller; the 133-MHz unit uses a 1.2GB Quantum Fireball Fast ATA-2 disk.

On our benchmark tests, both the 133MVP and the 166MVP posted good results on all tests in their respective processor classes. Their performances were highlighted by above-average scores on our Graphics WinMark 96 and CD-ROM WinMark 96 tests.

The units also have attractive support coverage: They come with a four-year parts-and-labor warranty, which also covers on-site service for all four years.—**AP Blue Thunder PHX133MVP Pro.** Direct price: \$2,549. **Blue Thunder PH166MVP Pro.** Direct price: \$3,599. DirectWave Inc., Ontario, CA; 800-882-8108, 909-390-8098; fax, 909-390-8061; <http://www.directwave.com>. Circle 454 on reader service card.

DTK Computer Inc.

DTK QUIN-55M/P166

Using Intel's new Triton II chip set, DTK Computer's \$3,270 QUIN-55M/P166 performed well in the competitive 166-MHz Pentium-based class. DTK supplies the QUIN-55 line primarily to resellers who then sell the PCs to corporate and government users looking for high-performance systems. Often sold with Windows NT, the QUIN-55 series is DTK's top PC line. The vendor's other two lines (not reviewed here) include the QUIN-54 line of corporate midrange systems and the QUIN-61 line for small- and home-office users.

The DTK tower PC uses a DTK motherboard with 512K pipelined-burst L2 cache, and EDO DRAM. These core components along with the unit's Quantum Fireball 1.2GB Fast ATA-2 hard

disk, Number Nine Imagine 128 graphics card with 4MB VRAM, and a TEAC 6X CD-ROM drive helped it attain average scores for its class on all of our tests.

A Creative Labs Sound Blaster Value

16 FM audio card and Lasonic 15-inch speakers round out the unit's multimedia components. A 15-inch monitor completes the hardware package. DTK provides a two-year warranty. On-site service for one year is a \$50 option.—**BB**

DTK QUIN-55M/P166. Street price: \$3,270. DTK Computer Inc., City of Industry, CA; 800-289-2385, 818-810-0098; fax, 818-810-0090; dtksales@dtkcomputer.com. Circle 455 on reader service card.



EPS Technologies Inc.

Evolution LP-133, Evolution XLP-166

Both the Evolution LP-133 and the Evolution XLP-166, from EPS Technologies, do an excellent job of meeting the needs of their target audiences. The \$2,295 (direct) LP-133 is intended for price-sensitive customers who want good performance for home or office use. The XLP-

SERVICE & RELIABILITY

DTK Computer Inc.

Reliability	Average
Repair	Average
Technical support	Average
Percent needing repair	Average

MidWest Micro PS-166 Office PC	NMC Expert Plus 133	NMC Expert Plus 166	NEC PowerMate V133	NEC PowerMate P166	NETIS N5166- ED PowerStation	Polywell PolyStation 133P	Polywell PolyStation 166P	Quantex OPS/133 SM-2	Quantex OPS/166 SM-2
\$3,199 (direct)	\$1,999 (direct)	\$3,699 (direct)	\$2,230 (street)	\$2,858 (street)	\$2,590 (direct)	\$2,100 (direct)	\$2,950 (direct)	\$2,649 (direct)	\$2,849 (direct)
Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166
16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Maxtor 7200AAP	Western Digital Caviar AC31600	Seagate ST31250W	Conner CFS1621A	Seagate ST32140A	Western Digital Caviar AC31600	Quantum Fireball 1280A	Seagate ST32140A	Seagate ST32140A	Seagate ST32140A
1.5GB EIDE	1.5GB EIDE	1GB Fast/Wide SCSI-2	1.5GB EIDE	2GB Fast ATA-2	1.5GB EIDE	1.2GB Fast ATA-2	2GB Fast ATA-2	2GB Fast ATA-2	2GB Fast ATA-2
Number Nine Motion 771	Cardex S3888	ASUSTek PCI- AV868	Alliance Promotion 6422	Matrox MGA Millennium	Diamond Stealth64 Video VRAM 3200	Diamond Stealth64 Video VRAM 3240	ATI Video Xpression	Diamond Stealth64 Video VRAM 3200	Diamond Stealth64 Video VRAM 3200
2MB VRAM	2MB DRAM	2MB DRAM	1MB DRAM	2MB WRAM	2MB VRAM	2MB VRAM	2MB SDRAM	2MB VRAM	2MB VRAM
Intel SRC- 1702LD (15.8, 17)	CTX 1565D (14, 15)	CTX 1785GMe (16, 17)	NEC MultiSync XV15 (14, 15)	NEC MultiSync XV15 (14, 15)	Sampo AlphaScan 15mx (14.3, 15)	Sampo AlphaScan 15mx (14.3, 15)	Sampo AlphaScan 17mx (16, 17)	MAG InnoVision OX1795 (16, 17)	MAG InnoVision OX1795 (16, 17)
Acer (6X)	Funai (6X)	Toray (4X)	Goldstar (6X)	Goldstar (6X)	Mitsumi (6X)	Toshiba (6X)	TEAC (6X)	Aztech (6X)	Aztech (6X)
Aztech Wavetech 3D	Sound Blaster 16	ASUSTek PCI- AV868	Integrated (OPTI 82C930A)	Integrated (OPTI 82C930A)	Sound Blaster 16	Sound Blaster 16	Sound Blaster AWE32	Ensoniq Soundscape	Ensoniq Soundscape
Labtec LCS-1022	MIDI Land MLI-178	Labtec LCS-800	NEC 8 WATTS	NEC 20 WATTS	JUSTer SP-890	Yamaha YST-M5	Yamaha YST-M5	Altec Lansing ACS31	Altec Lansing ACS31
512K	256K	512K	256K	256K	512K	256K	512K	512K	512K
Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
ASUSTek	ASUSTek	ASUSTek	G.V.C.	G.V.C.	Super Micro	Tyan	Tyan	Biostar	Biostar
Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX
3 years/3 years	3 years/3 years	3 years/3 years	3 years/3 years	3 years/3 years	1 year/3 years	3 years/5 years	3 years/5 years	1 year/1 year	1 year/1 year
N/A	\$39 (1 year)	\$39 (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	\$75 (1 year)	\$75 (1 year)	Included (1 year)	Included (1 year)

166 costs nearly twice as much (\$4,395) but adds high-end components to satisfy power users. A line of Pentium Pro workstations will also be available by the time you read this.

The two Evolution PCs include 17-inch monitors, Labtec speakers featuring Spatializer surround-sound technology, and 28.8/14.4-Kbps data/fax modems with full-duplex

speakerphone and voice features. The LP-133 comes with a collection of Compton's multimedia CDs, but the XLP-166 is all business, replacing edutainment with Microsoft Office Professional and Bookshelf for Windows 95. Both come with Lotus Organizer and Quicken Deluxe.

The LP-133 was in the middle of the pack in terms of performance. The unit had one performance highlight: an above-average score on our CD-ROM WinMark 96 test, thanks to its 6X CD-ROM drive.

The XLP-166 lives up to its high-performance promises. Loaded with 512K of L2 cache, a 4GB Fast/Wide SCSI-2 7,200-rpm hard disk, and a Number Nine Imagine 128 graphics card with 4MB of VRAM, the system posted above-average scores on our Winstone 32, Graphics, Disk, and

CD-ROM WinMark 96 tests. Other results were average for its class.

The units' warranty provides one year of on-site service, plus three years of parts-and-labor coverage.—AP

Evolution LP-133. Direct price: \$2,295. **Evolution XLP-166.** Direct price: \$4,395. EPS Technologies Inc., Jefferson, SD; 800-447-0921, 605-966-5586; fax, 605-966-5482; <http://www.epstech.com>.

Circle 456 on reader service card.

Everex Systems Inc.

Step Premier 133, Step Premier 166, Tempo Select 133, Tempo Select 166

Everex Systems has two different PC lines, both of which are sold through retail channels and VARs. The Step line—represented here by the \$2,749 Step Premier 133, an honorable mention in this roundup, and the \$4,749 Step Premier 166—is intended for higher-end users. The line offers longer warranty coverage and more flexible configurations than the Tempo line. The \$2,499 Tempo Select 133 and the \$3,399 Tempo

Select 166 are aimed at the price-sensitive buyer; they provide fewer expansion options and in some cases lesser components. All four machines were good performers; the 133-MHz units did especially well.

These four PCs are based on FIC motherboards. The Step PCs use Intel's Triton II chip set and EDO DRAM; the Tempos use a VIA chip set and Burst EDO DRAM. All but the Step 133 (which came with 256K) used 512K of pipelined-burst L2 cache. These systems also used 1.2GB Quantum Fireball hard disks, except for the Step 166, which relied on a 7,200-rpm Fast/Wide SCSI-2 model.

The four Everex machines are similarly outfitted inside with Sound Blaster AWE 32 wavetable audio cards, Matrox MGA Millennium graphics cards (with 2MB of VRAM for the 133s and 4MB for the 166s), and a 28.8/14.4-Kbps data/fax modem (V.34 models for the Step machines). Everex also includes 15-inch monitors and Labtec speakers with the

SERVICE & RELIABILITY

Everex Systems Inc.

Reliability	Average
Repair	Average
Technical support	Worse than average
Percent needing repair	Average

SUMMARY OF FEATURES

Pentium PCs

■ YES ■ NO
Products listed in review order

	Reason Savvy TR/Model 1	Reason Savvy TR/Model 2	Reason Square 5 TR/ITX	Reason Square 5 DP-TR2/HX	Robotech Cobra XLT/2 P133	Robotech Cobra XLT/2 P166	Royal Ultra Media Pro	Royal Media 96 Pro
Price of tested configuration	\$1,795 (direct)	\$1,995 (direct)	\$2,895 (direct)	\$3,995 (direct)	\$3,299 (direct)	\$4,399 (direct)	\$2,395 (direct)	\$3,895 (direct)
Processor	Pentium/120	Pentium/150	Pentium/166	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166
Installed RAM	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Hard disk manufacturer and model	Western Digital Caviar AC31200	Western Digital Caviar AC31200	Seagate ST32140A	Quantum Atlas XP32150W	Seagate ST31240A	Seagate ST31240A	Quantum Fireball 1280A	Seagate ST32560W
Capacity and interface	1.2GB EIDE	1.2GB EIDE	2GB Fast ATA-2	2GB Fast/Wide SCSI-2	2GB Fast ATA-2	2GB Fast ATA-2	1.2GB Fast ATA-2	2GB Fast/Wide SCSI-2
Graphics adapter	Diamond Stealth64 Video 2120	Diamond Stealth64 Video 2120	Integrated (S3 Triob4V+)	Number Nine Imagine 128	Number Nine Motion 771	Number Nine Imagine 128	ATI Video Xpression	Number Nine Imagine 128
Memory	1MB DRAM	2MB DRAM	2MB DRAM	4MB VRAM	2MB VRAM	4MB VRAM	2MB SDRAM	4MB VRAM
Monitor (and screen diagonal measured/claimed, in inches)	Goldstar Studio- works 56m 14 (14, 15)	Goldstar Studio- works 56m 14 (14, 15)	Nokia 447W (15.5, 17)	Samsung 17GLai (15.7, 17)	Samsung CMH7379L (15.7, 17)	Iiyama MF-8017E (15.7, 17)	MAG InnoVision DX1795 (16, 17)	MAG InnoVision MXP17F (16, 17)
CD-ROM drive (speed)	Mitsumi (4X)	Mitsumi (4X)	TEAC (6X)	TEAC (6X)	Plextor (6X)	Plextor (6X)	TEAC (6X)	Toshiba (6X)
Sound adapter	Diamond ESS1688	Diamond ESS1688	Crystal Lake Series 220	Ensoniq Soundscape	Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster AWE32 PnP	Sound Blaster AWE32 PnP
Speakers	None	None	Nokia 447W	Yamaha YST- M10	Yamaha YST- M10	Yamaha YST- M10	MIDI Land MLI- 691	Cambridge Soundworks
Installed external RAM cache	None	256K	256K	512K	512K	512K	512K	512K
Type of cache	N/A	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
Motherboard manufacturer	Reason	Reason	Intel	Tyan	Robotech	Robotech	Amitron	Quick Technology
Chip set manufacturer	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430HX	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX
Standard warranty on parts/labor	3 years/6 years	3 years/6 years	3 years/6 years	3 years/6 years	3 years/1 year	3 years/1 year	1 year/lifetime	1 year/lifetime
On-site service charge	\$49 (1 year)	\$49 (1 year)	\$49 (1 year)	\$49 (1 year)	Included (1 year)	Included (1 year)	N/A	N/A

N/A—Not applicable: The product does not have this feature.

133-MHz units and high-quality Yamaha YST-M10 speakers and 17-inch monitors with the 166-MHz PCs.

The Everex systems were all impressive performers, but it was the 133-MHz entries that shone, especially the Step 133. Both 133-MHz systems had above-average Graphics WinMark 96 scores, but the Step unit also had an above-average Winstone 96 result. The 6X CD-ROM drive found in all the systems resulted in above-average CD-ROM WinMark 96 scores for all four. Other test results for the 133s, as for the Pentium/166 units, were average.

Both lines come with 24-hour, 7-day telephone technical support, but the Tempo line has three years of parts-and-labor coverage, while the Step line has a five-year warranty. Both lines have on-site coverage for the first year.—AP

Step Premier 133. Street price: \$2,749. **Step Premier 166.** Street price: \$4,749. **Tempo Select 133.** Street price: \$2,499. **Tempo Select**

166. Street price: \$3,399. Everex Systems Inc., Fremont, CA; 800-383-7391, 510-498-1111; fax, 510-683-2186; <http://www.everex.com>. Circle 457 on reader service card.

Gateway 2000 Inc.

Gateway P5-133, Gateway P5-166

Leading-edge components, strong support, and great performance have been Gateway's recipe for success, and these two Pentium PCs keep up the tradition by providing attractive values in their respective CPU classes. The P5-133 (\$2,414 direct), an honorable mention in this roundup, is aimed at mainstream business buyers and the higher-powered P5-166 (\$3,609 direct) is intended to meet the needs of the early adopters, high-end users, and small-office and home users. Gateway 2000 also markets the Family PC line of multimedia home systems as well as the G6-200

tras, such as an emergency recovery and reinstallation disk, build a user's confidence in both the equipment and the company. Microsoft Office Professional and Bookshelf CD is also bundled.

These two units performed well within their respective classes. Both produced average scores on all major tests, with one highlight: an above-average score for the P5-133 on our Graphics WinMark 96 test. The systems' fast Matrox graphics cards, 4X Torisan CD-ROM drives (now standard with the 6X Wearnes CDD-620), and hard disks—a 2GB Fast ATA-2 for the P5-133 and a 2GB Fast SCSI-2 for the P5-166—no doubt helped. The P5-166 had 512K of pipelined-



Gateway P5-166

burst L2 cache and a 17-inch monitor; the P5-133 had 256K of cache and a 15-inch monitor.

These systems have a one-year-

SERVICE & RELIABILITY

Gateway 2000 Inc.

Reliability	Better than average
Repair	Better than average
Technical support	Better than average
Percent needing repair	Average

S.A.G. STA Dual 166 Ultra	SMD Mount Sheets	SMD Mount Olympus	Swan PowerHouse Deluxe 133	Swan PowerHouse Deluxe 166	Sys Performance P133T2A	Sys Performance C166T2A+	Tagram Thunderbolt Office Station P-133	Tagram Thunderbolt Virtual Studio P-166	Tangent MediaStar 5133
\$4,278 (direct)	\$2,375 (direct)	\$2,775 (direct)	\$2,573 (direct)	\$2,923 (direct)	\$2,329 (direct)	\$2,759 (direct)	\$2,095 (direct)	\$2,445 (direct)	\$2,195 (direct)
Pentium/166	Cyrix 6x86-P166+	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Cyrix 6x86-P166+	Pentium/133	Pentium/166	Pentium/133
16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Seagate ST15150W	Quantum Fireball 1280A	Quantum Fireball 1280A	Western Digital Caviar AC31600	Western Digital Caviar AC31600	Quantum Fireball 1280A	Quantum Fireball 1280A	Seagate ST32140A	Quantum Fireball 1280A	Quantum Fireball 1280A
3 9GB Fast/Wide SCSI-2	1 2GB Fast ATA-2	1 2GB Fast ATA-2	1 5GB EIDE	1 5GB EIDE	1 2GB Fast ATA-2	1 2GB Fast ATA-2	2GB Fast ATA-2	1 2GB Fast ATA-2	1 2GB Fast ATA-2
Number Nine Imagine 128 Series 2	Diamond Stealth64 Video VRAM 3240	Diamond Stealth64 Video VRAM 3240	STB Powergraph 64 Video	STB Powergraph 64 Video	Matrox MGA Millennium	Matrox MGA Millennium	Number Nine Imagine 128	Matrox MGA Millennium	STB Powergraph 64 Video
4MB VRAM	2MB VRAM	2MB VRAM	2MB EDO DRAM	2MB EDO DRAM	2MB WRAM	2MB WRAM	2MB VRAM	2MB WRAM	2MB EDO DRAM
Viewsonic 17PS (16, 17)	ADI MicroScan 4GP (13.6, 15)	ADI MicroScan 4GP (13.6, 15)	Sampo AlphaScan 15 (14, 15)	Sampo AlphaScan 15 (14, 15)	MAG InnoVision DX15T (14, 15)	MAG InnoVision DX15T (14, 15)	MAG InnoVision DX15F (14, 15)	MAG InnoVision DX17F (16, 17)	Sampo AlphaScan KDM (14, 15)
Plextor (6X)	Mitsumi (4X)	Creative Labs (6X)	Lyxcon (6X)	Lyxcon (6X)	TEAC (6X)	Toshiba (6X)	TEAC (6X)	TEAC (6X)	TEAC (6X)
Sound Blaster AWE32 PnP	Acer SP301	Sound Blaster 16	TeleVideo Tele- Wave Q32/SRS	TeleVideo Tele- Wave Q32/SRS	Acer SP301	Sound Blaster 16	Integrated (Vibra 16S)	Ensoniq Soundscape	Expert Media MED3240
NMB RT915CTW	Pioneer SP-60	Pioneer SP-60	Micro Inno- vations MM60P	Micro Inno- vations MM60P	MIDI Land MLi-65	MIDI Land MLi-65	QuickShot Sound Force 600	QuickShot Sound Force 600	Aura Sound AS3-75-4FR
512K	512K	512K	256K	256K	512K	512K	512K	256K	512K
Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst	Pipelined-burst
Tyan	ASUSTeK	ASUSTeK	ASUSTeK	ASUSTeK	ASUSTeK	ASUSTeK	BCM	BCM	Tyan
Intel 430HX	Intel 430HX	Intel 430HX	Intel 430FX	Intel 430FX	Intel 430HX	Intel 430HX	Intel 430HX	Intel 430FX	Intel 430FX
2 years/1 year	3 years/3 years	3 years/3 years	1 year/1 year	1 year/1 year	Varies/1 year	Varies/1 year	1 year/1 year	1 year/1 year	3 years/3 years
\$70 (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	Included (1 year)	\$95 (1 year)	\$95 (1 year)	\$50 (1 year)	\$50 (1 year)	Included (1 year)

labor and on-site warranty, with three years of parts coverage; 24-hour, 7-day toll-free technical support is also available.—AP

Gateway P5-133. Direct price: \$2,414. **Gateway P5-166.** Direct price: \$3,609. Gateway 2000 Inc., North Sioux City, SD; 800-846-2000, 605-232-2000; fax, 605-232-2023; <http://www.gw2k.com>. **Circle 458 on reader service card.**

GST/Micro City Inc.

Aapogee P133, Aapogee P166

The two representatives of the Aapogee line from GST/Micro City offer an appealing set of components for the money combined with mostly average performance. The Aapogee P133 and the P166 model have direct prices of \$2,495 and \$2,729, respectively, and are intended for corporate use.

The only substantive difference between these two systems is the choice of processor. Both offer strong features, including a 17-inch 0.28-mm dot-pitch Proton monitor with digital controls and integrated speakers, a 6X TEAC CD-ROM drive, Sound Blaster AWE32 wavetable



GST/Micro P166

audio cards, and a Key Tronic keyboard with Windows 95 keys. The monitor's speakers, however, face sideways instead of forward, which could lead to problems in a work environment where other people sit near

your workstation.

The GST systems kept pace with their respective competition across all of our benchmark tests, excepting a below-average CD-ROM WinMark 96 score for the P166. Both machines came equipped with a Number Nine Imagine 128 graphics card with 4MB of VRAM. The Aapogee P133 made the best use of this card's power, earning an above-average Graphics WinMark 96 score.

The Aapogee line comes with a one-year warranty; two years of on-site coverage is available for \$69.—AP

Aapogee P133. Direct price: \$2,495. **Aapogee P166.** Direct price: \$2,729. GST/Micro City, Cerritos, CA; 800-567-2764, 714-739-0106; fax, 714-739-8291; gst@primenet.com. **Circle 459 on reader service card.**

HD Computer

Victoria P-120, Victoria P-166

The two Victoria PCs from HD Computer cover all the bases to get the job done, offering solid performance and a good set of components. The Victoria P-120 is intended for the small- and home-office market and has a direct price of \$2,495; the Victoria P-166 system sells for \$3,395 and is aimed at corporate users.

Both systems are configured nearly identically. They each come with a 1.5GB hard disk, a 28.8/14.4-Kbps voice/data/fax modem, a 6X TEAC CD-ROM drive, and a stack of software including Microsoft Office Professional and Bookshelf for Windows 95. The P-166 included a 17-inch monitor and Yamaha speakers; its 120-MHz sibling came bundled with a 15-inch display and JUSTer speakers.

Both machines performed well on the majority of our tests. The P-120 was a standout within a small CPU group (two other PCs), posting above-average scores on most tests. What is more important, however, is that its scores were on a par with Pentium/133 averages. The P-166 model garnered mostly average

SUMMARY OF FEATURES

Pentium PCs

■ YES ■ NO

Products listed in review order

	Tangent MediaStar 5166	Tatung TCS-5100	Tatung TCS-5300	Unisys CWP-51333	Unisys CMT-51667	Unitak Skyraider	USA Flex PT133 Multimedia Special	US Computer Freedom LX+
Price of tested configuration	\$3,095 (direct)	\$2,195 (direct)	\$2,795 (direct)	\$2,579 (street)	\$4,010 (street)	\$2,695 (direct)	\$2,249 (direct)	\$2,349 (direct)
Processor	Pentium/166	Pentium/133	Pentium/166	Pentium/133	Pentium/166	Pentium/166	Pentium/133	Pentium/166
Installed RAM	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO	16MB EDO
Hard disk manufacturer and model	Quantum Fireball 1280A	Quantum Fireball 1280A	Quantum Fireball 1280A	Fujitsu M1814TAU	Fujitsu M1808SAU	Western Digital Caviar AC31600	Western Digital Caviar AC31600	Quantum Fireball 1080A
Capacity and interface	1.2GB Fast ATA-2	1.2GB Fast ATA-2	1.2GB Fast ATA-2	1GB Fast ATA-2	1GB SCSI-2	1.5GB EIDE	1.5GB EIDE	1GB Fast ATA-2
Graphics adapter	Matrox MGA Millennium	Diamond Stealth64 Video VRAM 3200	Diamond Stealth64 Video VRAM 3200	Integrated (Cirrus Logic CL-GD5436)	Number Nine Vision 330	Number Nine Imagine 129	STB Powergraph 64 Video	Diamond Stealth64 Video VRAM 3240
Memory	4MB VRAM	2MB VRAM	2MB VRAM	2MB DRAM	2MB VRAM	2MB VRAM	2MB EDO DRAM	2MB VRAM
Monitor (and screen diagonal measured/claimed, in inches)	Sampo Alpha-Scan KM 720 (16, 17)	Tatung CM-15 VBR (13.8, 15)	Tatung CM-15 VBR (13.8, 15)	Unisys EV6153-COL (13.8, 15)	Unisys EV6174-COL (15.8, 17)	ViewSonic 17EA (15.8, 17)	Panasonic Panasync C-1591E (13.5, 15)	Shamrock SRC 1502L D (13.7, 15)
CD-ROM drive (speed)	Diamond (8X)	Tatung (6X)	Tatung (6X)	Toshiba (4X)	Toshiba (4X)	Funai (6X)	Acer (6X)	TEAC (6X)
Sound adapter	Expert Media MED3240	Sound Blaster 16	Sound Blaster 16	Sound Blaster 16	Sound Blaster 16 IDE Value	Sound Blaster AWE32 Value	Integrated (MDW321)	Diamond Serie Sound LX
Speakers	Aura Sound AS3-75-4FR	None	None	Creative Labs SBS38	Creative Labs SBS38	None	Micro Innovations MM40P	Premier SP-115
Installed external RAM cache	512K	256K	256K	256K	256K	256K	256K	256K
Type of cache	Pipelined-burst	Pipelined-burst	Pipelined-burst	Asynchronous	Synchronous	Pipelined-burst	Synchronous	Pipelined-burst
Motherboard manufacturer	Tyan	Tatung	Tatung	Unisys	Unisys	Intel	Intel	Microstar
Chip set manufacturer	Intel 430FX	Intel 430FX	Intel 430FX	ALI M1511/2/3	Intel 430FX	Intel 430FX	Intel 430FX	Intel 430FX
Standard warranty on parts/labor	3 years/3 years	1 year/1 year	1 year/1 year	3 years/3 years	3 years/3 years	1 year/1 year	3 years/lifetime	2 years/lifetime
On-site service charge	Included (3 years)	\$30 (1 year)	\$30 (1 year)	Included (1 year)	Included (1 year)	\$75 (1 year)	\$49 (1 year)	\$59.95 (1 year)



HD Victoria P-166

graphics card with 2MB of VRAM.)

HD Computer provides one year of coverage for its systems. On-site service costs \$75 for the first year.—AP

Victoria P-120. Direct price: \$2,495. **Victoria P-166.** Direct price: \$3,395. HD Computer, Sunnyvale, CA; 800-347-0493, 408-720-0493; fax, 408-720-1967; <http://www.hdcomputer.com>. Circle 460 on reader service card.

Hertz Computer Corp.

Z-Pent P133e, Z-Pent P166e

These products from Hertz Computer Corp. make good performance affordable. The Z-Pent line, targeted at the corporate, government and educational markets, includes the entry-level \$2,175 (direct) Z-

Pent P133e, aimed at mainstream corporate users, and the high-end \$3,395 (direct) Z-Pent P166e, designed for more demanding applications. A 17-inch MAG InnoVision monitor comes with each PC.

The two systems feature Hertz motherboards with Triton chip sets and 512K pipelined-burst L2 cache; both also used an ATI Mach64-based ATI Winturbo graphics card. These components contributed to the units' average performances on both of our Winstone tests. The Z-Pent P133e also managed an average Graphics WinMark 96 score with the ATI card, but the Z-Pent P166e posted a below-average mark on this test.

The Z-Pent P133e included a 4X Toshiba CD-ROM drive while most competitors used 6X CD-ROM drives, so its CD-ROM WinMark 96 score was below average. The Z-Pent P166e came with a 6X Toshiba drive with excellent sequential read and access times, which helped it earn an above-average score on our CD-ROM WinMark tests.



Hertz P133e

Each system came equipped with a Creative Labs CT2502 audio card, which supports FM, wavetable, and waveguide synthesis. Hertz backs these systems with a one-year warranty; on-site service costs \$495 for the first year.—Richard S. Shim
Hertz Z-Pent P133e. Direct price: \$2,175. **Hertz Z-Pent P166e.** Direct price: \$3,395. Hertz Computer Corp., New York, NY; 800-232-8737, 212-684-4141; fax, 212-684-3658. Circle 461 on reader service card.

Hewlett-Packard Co.

Vectra VL Series 4 5/133, Vectra VL Series 4 5/166 MT, Vectra XM Series 4 5/120, Vectra 500 Model 515MCx 5/166

Hewlett-Packard provided four PCs for this roundup from three distinct Vectra product lines. The XM series, represented here by the \$2,815 (street) 120-MHz Vectra XM 4 5/120, comes network ready—through its integrated 10Base-T Ethernet chip set. It is designed for corporate installations, though it lacks both

Ends

US Computer Patriot LX+	Vectron Optima Station P133	Vectron Power Pro P166
\$2,799 (direct)	\$2,295 (direct)	\$4,495 (direct)
Pentium/166	Pentium/133	Pentium/166
16MB EDO	16MB EDO	16MB EDO
Western Digital Caviar AC31600	Seagate ST32140A	Seagate ST15150W
1 5GB EIDE	2GB Fast ATA-2	3 9GB Fast/Wide SCSI-2
Diamond Stealth64 Video VRAM 3240	Matrox MGA Millennium	Matrox MGA Millennium
2MB VRAM	2MB VRAM	2MB VRAM
MAG InnoVision DX17F (16, 17)	MAG InnoVision DX15T (14, 15)	MAG InnoVision DX17F (16, 17)
Toshiba (6X)	TEAC (6X)	Toshiba (6X)
Sound Blaster AWE32	Sound Blaster AWE32	Sound Blaster AWE32
Premier SP-115	Yamaha YST-M10	Yamaha YST-M10
512K	256K	512K
Pipelined-burst	Pipelined-burst	Pipelined-burst
Intel Supermicro	Intel Supermicro	Intel Supermicro
Intel 430FX	Intel 430FX	Intel 430FX
2 years/lifetime	4 years/4 years	4 years/4 years
\$59.95 (1 year)	\$50 (1 year)	\$50 (1 year)

a CD-ROM drive and sound-card support. We also tested two members of HP's value line, the Vectra VL 4 Series, for corporate applications where lower cost is important. The \$3,285 133-MHz Vectra VL 4 5/133 and the \$3,925 166-MHz Vectra VL 4 5/166 MT are competitively priced and offer adequate performance. But they have only a single built-in speaker and 4X CD-ROM drives. The VLs are essentially the same as the XM, but lack the network interface. The fourth machine, the \$3,430 (street) Vectra 500 Model 515MCx 5/166, is aimed at small businesses that have fewer than 100 employees. It offers many extras but was a poor performer.

HP sells two more Vectra lines. At the top is the XU line, designed with the latest technology to deliver the highest performance. The VE series consists of



HP Vectra 500

value-oriented entry-level PCs, with a performance level just below that of the VL series.

Each Vectra came with a 15-inch monitor, as well as 256K pipelined-burst L2 cache. An interesting feature they share is soft power-down, which allows you to turn the power on or off by pressing the spacebar on the keyboard; the XM model even has a feature that lets you power up remotely, via a network connection. All four Vectras are also DMI-compliant and have MIF browsers.

The Vectra 500 model comes with extras such as Microsoft Office Professional and Bookshelf for Windows 95 as well as Acrobat Reader so you can read .PDF files. Internet access is easy with Microsoft Internet Explorer 2.0. But instead of speakers, it has a headset with a boom mike that you can use with the system's telephony features. The unit includes a 28.8/14.4-Kbps DSVD modem and fax and voice mail software. Also included is host software to let you link to HP Remote Support, enabling the system's remote diagnostic capabilities.

On our benchmark tests, the XM and the two VL PCs posted mostly average scores. The VL units garnered below-average results on our CD-ROM tests; their 4X drives couldn't keep up in a field of competitors with 6X drives. The Vectra 500 performed poorly on both Winstone tests, likely affected by its last-place Graphics WinMark 96 score in its class. Its integrated S3 Trio 64V+ graphics chip set with 1MB of DRAM—slower than those used by others—no doubt influenced the result.

HP provides a three-year parts-and-labor warranty plus on-site service for one year on all the systems except the Vectra 500, which has one-year coverage.—*AP*
Vectra VL Series 4 5/133. Street price: \$3,285.
Vectra VL Series 4 5/166 MT. Street price: \$3,925.
Vectra XM Series 4 5/120. Street price: \$2,815.
Vectra 500 Model 515MCx 5/166. Street price: \$3,430. Hewlett-Packard Co., Palo Alto, CA; 800-752-0900; fax, 970-635-1000; <http://www.hp.com>. *Circle 462 on reader service card.*

HiQuality Computer Systems

HiQ P133 Mars Station, HiQ P166 Mars Station

The HiQ Mars Stations from HiQuality Computer Systems offer leading-edge features—such as Intel's new Triton II chip set, 17-inch Princeton monitors, and Fast Ethernet adapters—and competitive performance at a fair price. The HiQ P133 Mars Station has a direct price of \$2,765 and is intended for cost-conscious users in home and office settings. The \$3,999 HiQ P166 Mars Station is aimed at high-end corporate users. HiQ also offers the Apollo line of entry-level corporate PCs and the Saturn line of PCs for small businesses.

Their prices may be a bit higher than those of other PCs with similar CPU lev-



els, but there are good reasons for the extra cost. Both come with 512K of pipelined-burst L2 cache, 6X CD-ROM drives, Number Nine Imagine 128 graphics cards with 2MB of VRAM, and 3Com 10/100-Mbps Fast Ethernet adapters. The units also came with Sound Blaster AWE32 audio cards capable of wavetable synthesis, and a pair of Yamaha stereo speakers with subwoofer. Microsoft Office Professional for Windows 95 jump-starts the software side of the equation.

The P133 Mars Station was an average performer on most of our benchmark tests but managed above-average results on our Graphics WinMark 96 and CD-ROM WinMark 96 tests. The 166-MHz model, with its 2GB 7,200-rpm Quantum Grand Prix Ultra SCSI hard disk, posted a top-three Disk WinMark 96 score. (The 133-MHz unit used a 1.2GB Quantum Fireball Fast ATA-2 hard disk.) The other test scores of the P166 unit were average for its processor class.

HiQ offers a one-year-parts, two-year-labor warranty with its systems. Two-year and three-year on-site service contracts are available at additional cost.—*AP*
HiQ P133 Mars Station. Direct price: \$2,765.
HiQ P166 Mars Station. Direct price: \$3,999. HiQuality Computer Systems, Sunnyvale, CA; 800-827-5836, 408-245-5836; fax, 408-245-3108; <http://www.hiq.com>. *Circle 463 on reader service card.*

SERVICE & RELIABILITY

Hewlett-Packard Co.

Reliability	Better than average
Repair	Better than average
Technical support	Better than average
Percent needing repair	Better than average

IBM Personal Computer Co.

IBM PC 350 P133 IBM PC 350 P166

IBM is a dependable company, and the components in these two PC 350 units—such as their 17-inch monitors—are top quality. If you don't demand the fastest performance and aren't tightly constrained by a budget, you could be satisfied with either the \$3,484 PC 350 P133 or the \$4,258 PC 350 P166 model (list prices). The PC 300 series—of which the 350s are a part—is positioned to showcase the latest and best technology available for corporate users. IBM also sells the PC 700 series to corporate buyers, as well as its Aptiva home PCs.

You will notice right away that the PC 350s' mini-tower case has an unusual design. There is a sliding hatch that can be moved in front of the drive bays and locked in place, preventing users from unauthorized access.

The systems also came packaged with Sound Blaster AWE32 wavetable audio cards, 6X TEAC CD-ROM drives, microphones and voice-recognition software. Both are also DMI-compliant and come with the client version of IBM's NetFinity software. As might be expected from IBM, the documentation was exceptional. On the other hand, the speakers were only average and the motherboard has just two PCI slots, which limits expansion possibilities.

Both PCs posted average scores for their respective processor classes on both Winstone tests as well as most other benchmark tests. Their Graphics WinMark 96 scores were above average for their respective groups, thanks largely to Matrox MGA Millennium graphics accelerator cards with 4MB of WRAM.

IBM provides a three-year on-site service warranty, and telephone techni-

cal support is available 24 hours a day, 7 days a week.—AP

IBM PC 350 P133. List price: \$3,484. **IBM PC 350 P166.** List price: \$4,258. IBM Personal Computer Co., Research Triangle Park, NC; 800-426-2968; <http://www.pc.ibm.com>. Circle 464 on reader service card.

Maximus Computers Inc.

Magna Media P/133, Magna Graphics Media P/166, Magna SCSI Media P/166

Maximus Computers sent us PCs representing three different lines for this roundup. All are competitive performers in their respective classes: the \$2,399 Magna Media P/133 for small and home businesses; the \$3,199 Magna Graphics Media P/166 for multimedia and graphics power users; and the loaded \$5,399 Magna SCSI Media P/166 for graphic artists (all prices are direct).

The Magna Media P/133 with a Triton chip set, 512K of pipelined-burst L2 cache, and a Matrox MGA Millennium 2MB WRAM graphics card came in above its CPU group's averages on our Winstone 96 and Graphics WinMark 96 tests. A TEAC 6X CD-ROM drive helped in its above-average CD-ROM

WinMark 96 score. Its Disk WinMark 96 and CPUmark scores were average. The system includes a MAG 15-

inch monitor, Sound Blaster AWE32 wavetable audio card, JUSTer speakers, and a Zoom 28.8/14.4-Kbps data/fax modem.

The midrange Magna Graphics Media P/166 with 512K pipelined-burst L2 cache and Triton chip set posted average scores on most tests. The Matrox MGA Millennium graphics card with 2MB of WRAM and the Toshiba 6X CD-ROM drive aided in above-average Graphics WinMark and CD-ROM WinMark results. The Magna Graphics Media P/166 features a Sound Blaster AWE32 wavetable audio card paired with JUSTer speakers, a GVC 33.6/14.4-Kbps fax modem, and a MAG 17-inch monitor.

Maximus's top-line Magna SCSI

Media P/166 employs many high-end components, including 512K pipelined-burst L2 cache, a 2GB 7,200-rpm Fast/Wide SCSI-2 hard disk, and Matrox MGA Millennium graphics card with 4MB of WRAM. On our benchmark tests, the unit posted competitive scores, highlighted by above-average Graphics WinMark and CD-ROM WinMark scores.

The Magna SCSI Media P/166 also included a MAG 17-inch monitor, a U.S. Robotics 33.6/14.4-Kbps DSVD modem, a Plextor 6X CD-ROM drive, a Sound Blaster AWE32 wavetable sound card, and Jazz speakers. An HP SureStor 4020i recordable CD-ROM drive was included for backup purposes.

All three systems included a choice of Lotus SmartSuite 96 or Microsoft Home Bundle and come with a four-year parts-and-labor warranty that includes four years of on-site service.—BB

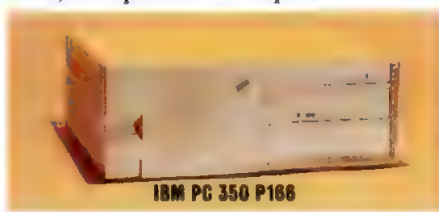
Magna Media P/133. Direct price: \$2,399. **Magna Graphics Media P/166.** Direct price: \$3,199. **Magna SCSI Media P/166.** Direct price: \$5,399. Maximus Computers Inc., Monrovia, CA. 800-888-6294, 818-305-5925; fax, 818-357-9140; <http://www.maximusp.com>. Circle 465 on reader service card.

Mega Computer Systems

Impact 5133PCI16D, Impact 5166PCI16MT

Moderately priced with correspondingly moderate performance, Mega Computer Systems' \$2,075 Mega Impact 5133PCI16D for small businesses and the \$2,900 Mega Impact 5166PCI16MT for high-performance business applications are reasonable buys. Mega Computer also sells the Horizon line of multimedia home PCs.

The Pentium/133-based Impact 5133PCI16D came equipped with 256K of pipelined-burst L2 cache, EDO DRAM and a Diamond Stealth64 Video 2201 graphics adapter with 2MB of EDO DRAM. Most test scores were average: The highlight was an above-average CD-



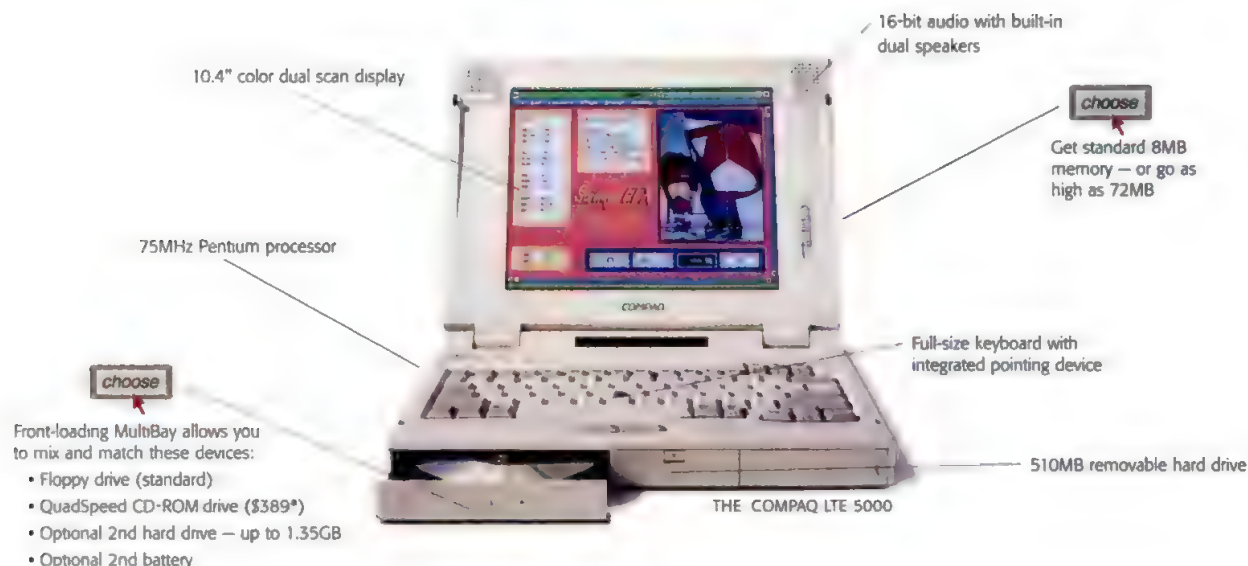
IBM PC 350 P166

SERVICE & RELIABILITY

IBM Personal Computer Corp.

Reliability	Better than average
Repair	Better than average
Technical support	Better than average
Percent needing repair	Better than average

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ROM WinMark 96 score thanks to a Toshiba 6X CD-ROM drive. A 1.2GB EIDE hard disk, a Creative Labs AWE32 FM wavetable audio card, and a 15-inch MGC monitor are also included.



The move up to the Pentium/166-based Impact 5166PCI16MT system will net you a toolless tower case and a 2GB 7,200-rpm Fast SCSI-2 hard disk. But many of the internal components are the same as the Impact 5133PCI16D's.

The Impact 5166PCI16MT posted mostly average scores. Its Graphics WinMark 96 score was below average, however, and its CD-ROM WinMark was above average, thanks to a Toshiba 6X CD-ROM drive. The Impact 5166PCI16MT also includes a 10-Mbps Ethernet adapter.

Mega Computer's two-year-parts and one-year-labor warranty is backed by toll-free technical support during weekday business hours, Pacific time. On-site service is not available.—BB

Impact 5133PCI16D. Direct price: \$2,075.
Impact 5166PCI16MT. Direct price: \$2,900.
Mega Computer Systems, San Diego, CA; 800-338-6628, 619-487-8888; fax, 619-485-1518; <http://www.megacs.com>; sales@megacs.com. Circle 466 on reader service card.

Memorex Telex Corp.

Celerria Mini Tower

Memorex Telex has put together a corporate system with a great price—just \$2,295 (list). The Celerria Mini Tower's inexpensive package, however, delivered performance that was among the slowest in the 133-MHz class, which may dissuade some buyers. Memorex Telex builds each system to order, varying both hardware and software to suit your needs.

A mini-tower case housed the Celerria's motherboard with 256K of slow asynchronous L2 cache (256K pipe-



lined-burst is now standard for the same price) and standard DRAM. This combination contributed to the unit's below-average scores on both CPUmark measures. A comparatively slow 4,500-rpm 1.2GB hard disk and DRAM-based graphics card negatively affected all other test scores, which were below its CPU group's averages by a wide margin in most cases.

Also included in the package was a Philips 15-inch monitor that offered excellent picture quality and integrated speakers; we received a pair of Koss speakers as well. The company also bundles Quicken SE, Compton's Encyclopedia and Corel Photo CD Sampler with the system.

We were disappointed with some of the unit's documentation. The user manual was vague and included inaccurate diagrams, one of which was labeled in French while the rest of the manual continued in English (the company says that this has been corrected).

The system comes with a one-year warranty for parts and labor that includes on-site service. The company also offers 24-hour, 7-day toll-free technical support.—CL

Celerria Mini Tower. List price: \$2,295.
Memorex Telex Corp., Irving, TX; 800-944-4455, ext. 7788, 214-714-7660; fax, 214-714-7620; <http://www.mtc.com>; info@mtc.com. Circle 467 on reader service card.

Micro Express

MicroFlex-686/P166+

Marketed as an affordable corporate machine, the MicroFlex-686/P166+ provides the high-end performance of a 166-MHz Pentium via a Cyrix 6x86 P166+ processor. The unit's benchmark test scores belied its \$2,399 street price; this machine may be David to the Intel Goliath. The MicroFlex line also includes the Cyrix 6x86 P120+, the Cyrix 6x86-P150+, and Pentium-based systems ranging from 100-MHz to 166-MHz.

The MicroFlex produced the fourth-highest Winstone 96 score in our roundup and a top-five Winstone 32 score. Configured with 512K of pipelined-burst secondary processor cache, a 1.2GB Quantum Fireball Fast ATA-2 hard disk, and a Matrox Millennium graphics card with 2MB



of VRAM, the unit was an average performer among Pentium/166 machines on our Disk WinMark 96, Graphics WinMark 96, and CPUmark tests. The unit's Sony 4X CD-ROM drive—playing in a field of 6X mechanisms—scored well below average on our CD-ROM WinMark 96 tests.

The MicroFlex also comes with a 16-bit Creative Labs sound card capable of FM and wavetable synthesis, and stereo speakers by MLi. It was bundled with a 15-inch GVC monitor as well.

Micro Express includes a two-year parts-and-labor warranty and free round-the-clock telephone technical support with its unit. On-site service costs \$50 for one year.

The company also offers a 30-day money-back guarantee.—CM

MicroFlex-686/P166+. Street price: \$2,399.
Micro Express, Irvine, CA; 800-989-9900, 714-852-1400; fax, 714-852-1225; <http://www.wpages.com/microexpress/>. Circle 468 on reader service card.

Micron Electronics

Millennia 133 Millennia 166 Millennia Plus



Micron Electronics' use of leading-edge components—such as Intel's new ATX motherboard—pays off with strong benchmark test performances for the Millennia machines. The well-made Micron PCs deliver great performance for the dollar, from the \$3,148 133-MHz Millennia 133 for midrange users to the \$3,517 166-MHz Pentium Millennia 166 high-end IDE desktop PC for performance-heavy applications—both are Editors' Choices in this roundup. The \$5,405 166-MHz Millennia Plus is a no-compromise SCSI system configured for graphics and desktop publishing use. Micron also offers the entry-level business PowerStation line, Home MPC home system line, and Pentium Pro-based Magnum Line.

All three machines use Intel's new Triton II PCI chip set and 256K pipelined-burst L2 cache. Each came with a Number Nine Imagine 128 Series 2 graphics card with 4MB VRAM, a Creative Technolo-

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gy FM wavetable audio card, Advent speakers, and a MAG 17-inch monitor. For software, the Millennias include Microsoft Office Professional for Windows 95 with Bookshelf for Windows 95.

The Millennium 133 posted an above-average score on our Graphics WinMark 96 test and an average score on our Disk WinMark 96 tests, because of components like a 1.2GB Quantum Fireball E-IDE hard disk and the Number Nine graphics card. The unit's Sanyo 6X CD-ROM drive produced a competitive CD-ROM WinMark 96 score.

The Millennium 166 used the same hard disk and graphics card as the Millennium 133 system. Its benchmark performance was highlighted by the number-two Graphics WinMark score of the roundup. The unit's CD-ROM WinMark 96 score was very low, despite its 8X Hitachi CD-ROM drive.

The Millennium Plus is loaded with extras, including a Motorola BitSurf ISDN modem, a 3Com 10/100-Mbps Fast Ethernet card, and Advent AV370 speakers with a separate subwoofer. The tested configuration also includes a 1GB Iomega Jaz drive. The Millennium Plus garnered this roundup's best Disk WinMark score, thanks to its 2GB Fast/Wide SCSI-2 7,200-rpm hard disk. All other results were competitive within its CPU group.

Micron's round-the-clock toll-free technical support backs the company's three-year-parts and one-year-labor warranty, which includes five-year on-site service. There is also a first-year warranty on the CPU and memory.—BB

Millennia 133. Direct price: \$3,148. **Millennia 166.** Direct price: \$3,517. **Millennia Plus.** Direct price: \$5,405. Micron Electronics Inc., Nampa, ID; 800-388-6334, 208-893-3434; fax, 208-893-3424; <http://www.mei.micron.com> Circle 469 on reader service card.

SERVICE & RELIABILITY

Micron Electronics Inc.

Reliability	Better than average
Repair	Better than average
Technical support	Better than average
Percent needing repair	Average

MidWest Micro

P5-133 Office PC, P5-166 Office PC

MidWest Micro's multimedia P5-133 Office PC (\$2,499 direct) and P5-166 Office PC (\$3,199 direct) are designed to meet home and business needs; they offer a good mix of components and software backed by a comprehensive warranty. The P5-133 Office PC was the better performer of the two, earning average scores for its class on most tests, while the P5-166 Office PC faltered on three key tests.

Though the P5-133 was the better performer in its class, the P5-166 offers an upgraded set of features. The P5-133's Midwest Micro/Infotel monitor measures 14 inches at the diagonal while the P5-166's screen measured 16 inches. The P5-166 also includes a microphone and a 28.8/14.4-Kbps data/fax modem with voice features. A Microsoft Office Pro and Bookshelf CD is bundled with both machines. The P5-166 adds Microsoft Encarta 96, Co-Session, and *Surviving Day One with Windows 95* from Phoenix Publishing.

Both PCs came with 6X CD-ROM drives (an 8X drive is now standard with the P5-166), 1.5GB EIDE hard disks, and Aztech Waverider 3-D sound cards. Although the audio card is capable of FM

SERVICE & RELIABILITY

MidWest Micro

Reliability	Better than average
Repair	Average
Technical support	Average
Percent needing repair	Average

and wavetable synthesis, the included Labtec LCS-1022 speakers were too weak to take full advantage of that sound range.

The P5-133 was an average performer, except for a below-average Graphics WinMark 96 score. The P5-166 garnered below-average marks on the Winstone 32, Graphics WinMark, and Disk WinMark 96 tests.

The units' CPU, modem and memory modules are protected by a five-year warranty. All other components have three-year coverage on parts and labor.—CL

P5-133 Office PC. Direct price: \$2,499. **P5-**



166 Office PC. Direct price: \$3,199. Midwest Micro, Fletcher, OH; 800-203-3012, 513-368-2309; fax, 800-562-6622; <http://www.mwmicro.com>. Circle 470 on reader service card.

National Microcomputers Inc.

Expert Plus 133, Expert Plus 166

National Microcomputers aims its \$1,999 Expert Plus 133 at first-time or home users; its \$3,699 Expert Plus 166 is geared towards the professional user. Both machines were average performers within their respective CPU groups, except for poor scores on our Graphics WinMark 96 test. National Microcomputers, a direct vendor, builds PCs for corporate and government clients.

The Pentium 133-based Expert Plus 133 comes with a 1.5GB Western Digital hard disk and an S3 Trio64-based graphics adapter. The system also includes a Sound Blaster audio board, MLI-178 speakers, a 6X CD-ROM drive, and a 15-inch CTX monitor.

The Pentium 166-based Expert Plus 166 includes a Toray Phasewriter optical drive that stores up to 650MB of data and doubles as a quad-speed CD-ROM drive. The system also features a 1GB Fast/Wide SCSI-2 hard disk, a 17-inch CTX monitor, and an internal U.S. Robotics Sportster 28.8-Kbps V.34 modem.

The systems' below-average Graphics WinMark 96 test results within their respective CPU groups were due to their graphics cards. The Expert Plus 133 had a DRAM-based graphics card, and the Expert Plus 166 used ASUS's combination PCI graphics/16-bit sound card based on S3's older Vision868 chip set.

Both machines come with a three-year parts-and-labor warranty. On-site service is \$39 for one year.—CL

Expert Plus 133. Direct price: \$1,999. **Expert Plus 166.** Direct price: \$3,699. National Microcomputers Inc., Murray, UT; 800-800-4662, 801-265-3700; fax, 801-265-3783; <http://www.sina.com/natmicrosys>. Circle 471 on reader service card.



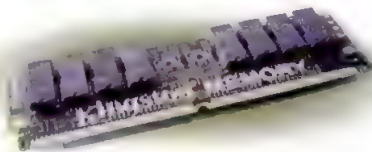


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NEC Technologies

PowerMate V133, PowerMate P166

NEC Technologies' PowerMate PCs—represented here by the \$2,230 PowerMate V133 and the \$2,858 PowerMate P166—are both competitively priced. But if performance is a major consideration, the P166 may be the better buy. NEC markets the PowerMate V133 as a mid-level corporate value system, while the PowerMate P166 is intended for the corporate power user. NEC's other lines are the PowerMate Ve, an entry-level value line, and the Pentium Pro-based PowerMate Pro series.

Both machines use GVC motherboards with Intel Triton chip sets, EDO DRAM, and pipelined-burst 256K L2 cache. NEC sticks to its corporate focus by outfitting these DMI-compliant machines with MIF browsers and drivers for all major NOSs. Additional hardware includes Goldstar 6X CD-ROM drives, integrated Opti FM synthesis audio chips, 15-inch NEC monitors, and NEC speakers.

The PowerMate V133 posted below-average scores on all major tests except the CPUmark. The culprit was its Conner 1.5GB EIDE hard disk, which has a very slow 3,600-rpm rating. Its Alliance Promotion 6422 graphics card with 1MB of DRAM also held back performance. On the bright side, the unit scored above the average on the CD-ROM WinMark 96 test.

The PowerMate P166 posted average scores on most of our benchmark tests. This machine uses a Seagate 2GB EIDE drive and a Matrox Millennium graphics card with 2MB of WRAM.

NEC covers these desktop systems with a standard three-year parts-and-labor warranty backed by 24-hour, 7-day, toll-

SERVICE & RELIABILITY

NEC Technologies Inc.

Reliability	Average
Repair	Average
Technical support	Average
Percent needing repair	Better than average

free technical support. On-site service is included for the first year.—BB

PowerMate V133. Street price: \$2,230.
PowerMate P166. Street price: \$2,858.
NEC Technologies, Boxborough, MA; 800-632-4636; fax, 800-366-0476; <http://www.nec.com> Circle 472 on reader service card.

NETiS Technologies Inc.

N5166-ED PowerStation

Targeted at small and home-office buyers, NETiS built the N5166-ED PowerStation to be a reliable workhorse with multimedia amenities for those after-hours DOOM sessions. The N5166-ED PowerStation (\$2,590 direct) unfortunately was not a strong performer on our benchmark tests, posting scores below the Pentium/166 average on most measures.

Among this unit's peripherals were a Microsoft Natural keyboard and a Logitech sculpted mouse. An internal U.S. Robotics Sportster 28.8-Kbps V.34 modem with voice features is a big plus for home-office users. For the games fanatic, the N5166-ED PowerStation includes a Sound Blaster 16 audio card and a pair of 25-watt JUSTer Active SP-690 speakers. Although the speakers provided excellent bass, sound was distorted at high volumes. Also included is a Sampo AlphaScan 15-inch monitor.

The N5166-ED PowerStation uses a SuperMicro motherboard with an Intel Triton chip set. Although it used 512K of L2 cache, it posted average CPUmark scores. On most tests, the NETiS PC posted below-average scores; the one exception was its average Disk WinMark 96 result.

The system is backed by a three-year parts-and-labor warranty with one year of on-site service. Three additional years of on-site service is \$200.—CL

N5166-ED PowerStation. Direct price: \$2,590. NETiS Technologies Inc., Milpitas CA; 800-577-7526, 408-263-0368; fax, 408-263-4624. <http://www.netistech.com>. Circle 473 on reader service card.

Polywell Computers Inc.

PolyStation 133P, PolyStation 166P

Polywell Computers designed the \$2,100 PolyStation 133P for the mainstream corporate buyer and the \$2,950 PolyStation 166P for the corporate power user (both prices are direct). Both PolyStations were average performers; however, the PolyStation 166P shone through with an excellent Graphics WinMark 96 score.

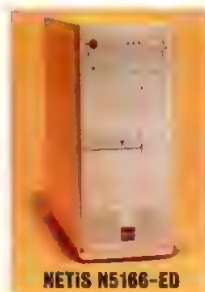
Although both systems use Tyan motherboards, the PolyStation 133P has 256K L2 cache while the PolyStation 166P has 512K of L2 cache. The PolyStation 133P comes with the Diamond Stealth64 Video VRAM 3240 graphics card and a 1.2GB Quantum Fireball hard disk. The PolyStation 166P used an ATI Video Xpression graphics board and a 2GB Seagate hard disk.

Both Polywell machines were average performers within their respective CPU groups on most of our benchmark tests. The exception was an above-average Graphics WinMark score for the PolyStation 166P.

To make the PolyStation 166P a power user's multimedia PC, Polywell installed a 6X CD-ROM drive, a Sound Blaster AWE32 wavetable audio board, a 17-inch Sampo monitor, and Yamaha YST-M5 speakers. The PolyStation 133P includes a 4X CD-ROM drive, a Sound Blaster 16 card, a 15-inch monitor, and identical Yamaha speakers. Polywell bundles Novell's Perfect Office 3.0 with both.

Polywell systems are backed by a five-year service warranty, with three years of parts coverage. On-site service is available for \$75 for one year and \$250 for three years.—CL

PolyStation 133P. Direct price: \$2,100. **PolyStation 166P.** Direct price: \$2,950. Polywell Computers Inc., South San Francisco, CA; 800-999-1278, 415-583-7222; fax, 415-583-1974; <http://www.polywell.com>; polywell@ix.netcom.com. Circle 474 on reader service card.





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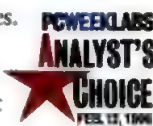
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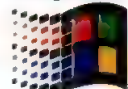


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CIRCLE 186 ON READER SERVICE CARD

Quantex Microsystems Inc.

Quantex QP5/133 SM-2, Quantex QP5/166 SM-2

Quantex's SM-2 line of aggressively priced PCs—represented here by the 133-MHz QP5/133 SM-2 (\$2,649 direct) and the 166-MHz QP5/166 SM-2 (\$2,849 direct)—is marketed at small- or home-office buyers. The line emphasizes multimedia features and bundled software. In our testing, both Quantex PCs achieved scores that were on a par with their respective competition. The vendor also sells the M-4 series of family PCs and the WS workstation series.

Both Quantex systems use Biostar motherboards based on Intel Triton chip sets, 256K of pipelined-burst L2 cache, and EDO DRAM. Both machines also included 2GB Seagate ST32140A hard disks and Diamond Stealth64 Video VRAM 3200 graphics accelerator cards.



On our benchmark tests, these two entries were average performers on all measures, except for the Quantex QP5/133's above-average score on our Graphics WinMark 96 tests.

The Quantex machines include 17-inch MAG monitors, Diamond 28.8-Kbps fax modems, 6X Aztech CD-ROM drives, Ensoniq wavetable audio cards, and Altec Lansing ACS31 speakers. Software bundled with both includes Astound, Grolier's Multimedia Encyclopedia, Novell Perfect Office, Phone Disc Business 95, Quicken SE, and SharkWare contact manager, as well as a few games.

Quantex Microsystems offers a one-year parts-and-labor warranty that includes on-site service with these systems. Lifetime toll-free telephone technical support is available, but it is not round-the-clock.—CL

Quantex QP5/133 SM-2. Direct price: \$2,649.
Quantex QP5/166 SM-2. Direct price: \$2,849.
Quantex Microsystems Inc., Somerset, NJ; 800-613-2047, 908-563-4166; fax, 908-563-0407; <http://www.quantex.com>; sales@quantex.com. Circle 475 on reader service card.

Reason Technology Inc.

Savvy TR/Model 1, Savvy TR/Model 2, Square 5 TR/ITX, Square 5 DP-TR2/HX

Top-notch performance and leading-edge components make the Pentium/166 Square 5 DP-TR2/HX a tough system to beat. Priced at \$3,995, the Winstone champion of this roundup was the most impressive offering from Reason Technology. The 166-MHz Square 5 TR/ITX (\$2,895) was mostly a low-average performer, but integrated features allow for easy setup for its target audience of general business users. Both Savvy machines—the Pentium 120-based, \$1,795 TR/Model 1 and the Pentium 150-based, \$1,995 TR/Model 2—are very attractively priced, but were poor performers.

The Square 5 DP-TR2/HX was built for speed, using a Tyan motherboard, Triton II chip set, and 512K of L2 cache. Graphics acceleration was provided by a Number Nine Imagine 128 adapter; and storage needs are met with a 7,200-rpm Fast/Wide SCSI-2 hard disk. These components paid off on our tests: The Square 5 DP-TR2/HX posted number-one Winstone 96 and Winstone 32 scores. All other scores were above average for its 166-MHz CPU group.

The Square 5 TR/ITX was built to be a hassle-free PC with many features integrated on its Triton-based motherboard, including graphics (S3's Trio 64V+ chip set with 2MB of DRAM) and wavetable sound. On our benchmark tests, the Square 5 TR/ITX was an average performer across the board, except for its below-average mark on our Graphics WinMark 96 tests. Reason bundles a 17-inch Samsung monitor with the Square 5 DP-TR2/HX; while the Square 5 TR/ITX includes a 17-inch Nokia monitor with built-in speakers.

The Savvy Model 1, one of only three Pentium/120 PCs in this roundup, also posted the lowest scores of all machines tested. Its poor performance is directly attributable to its slow, 4,500-rpm hard disk, and the fact that it has no L2 cache. The Model 2 was the only Pentium/150 tested, and its performance was on a par with the Pentium/133 entries. It used the same hard disk as the Model 1, but it included 256K of

L2 cache. Goldstar StudioWorks 15-inch monitors with integrated speakers are included with both Savvys.

Reason Technology offers a six-year-labor, three-year-parts warranty. The cost of replacement parts is prorated in the subsequent three years. On-site service is \$49 for one year.—CL

Savvy TR/Model 1. Direct price: \$1,795.

Savvy TR/Model 2. Direct price: \$1,995.

Square 5 TR/ITX. Direct price: \$2,895.

Square 5 DP-TR2/HX. Direct price: \$3,995.

Reason Technology Inc., Minneapolis, MN; 800-800-4860, 612-780-4792; fax, 612-780-4797. <http://www.reasontech.com>. Circle 476 on reader service card.



Robotech Inc.

Cobra XLT/2 P133, Cobra XLT/2 P166

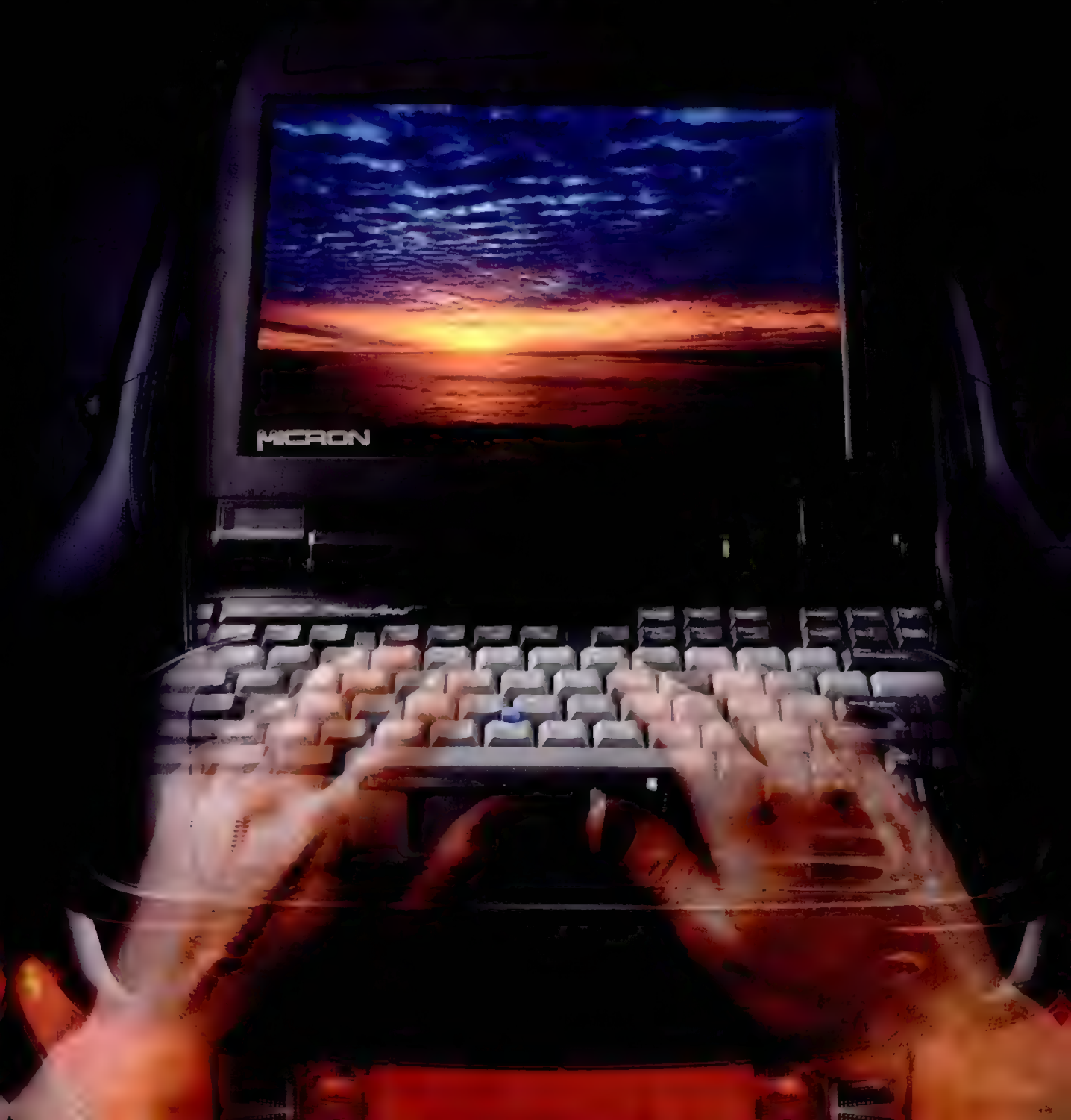
The SCSI-based Cobra XLT/2 line of PCs from Robotech is targeted at corporate power users and high-end home users. For this roundup, we looked at the \$3,299 Cobra XLT/2 P133, and the \$4,399 Cobra XLT/2 P166. Both were competitive performers on all benchmark tests in their respective CPU classes. Robotech also offers an XLT line of PCs, without SCSI, with slightly lower prices.

The Cobras feature compelling software and hardware, such as Groupwise 4.1, Quattro Pro 6.0, and Novell's WordPerfect 6.0, as well as 3Com 10/100-Mbps Fast Ethernet adapters, on-board PCI Fast SCSI-2 and external SCSI-2 connectors. Both also have Boca 28.8-Kbps modems that support voice mail, full-duplex speakerphone functions, and caller ID; 17-inch monitors; Sound Blaster wavetable audio cards; and Yamaha YST-M10 speakers.

With 512K of pipelined-burst L2 cache, the systems posted average CPUmark and



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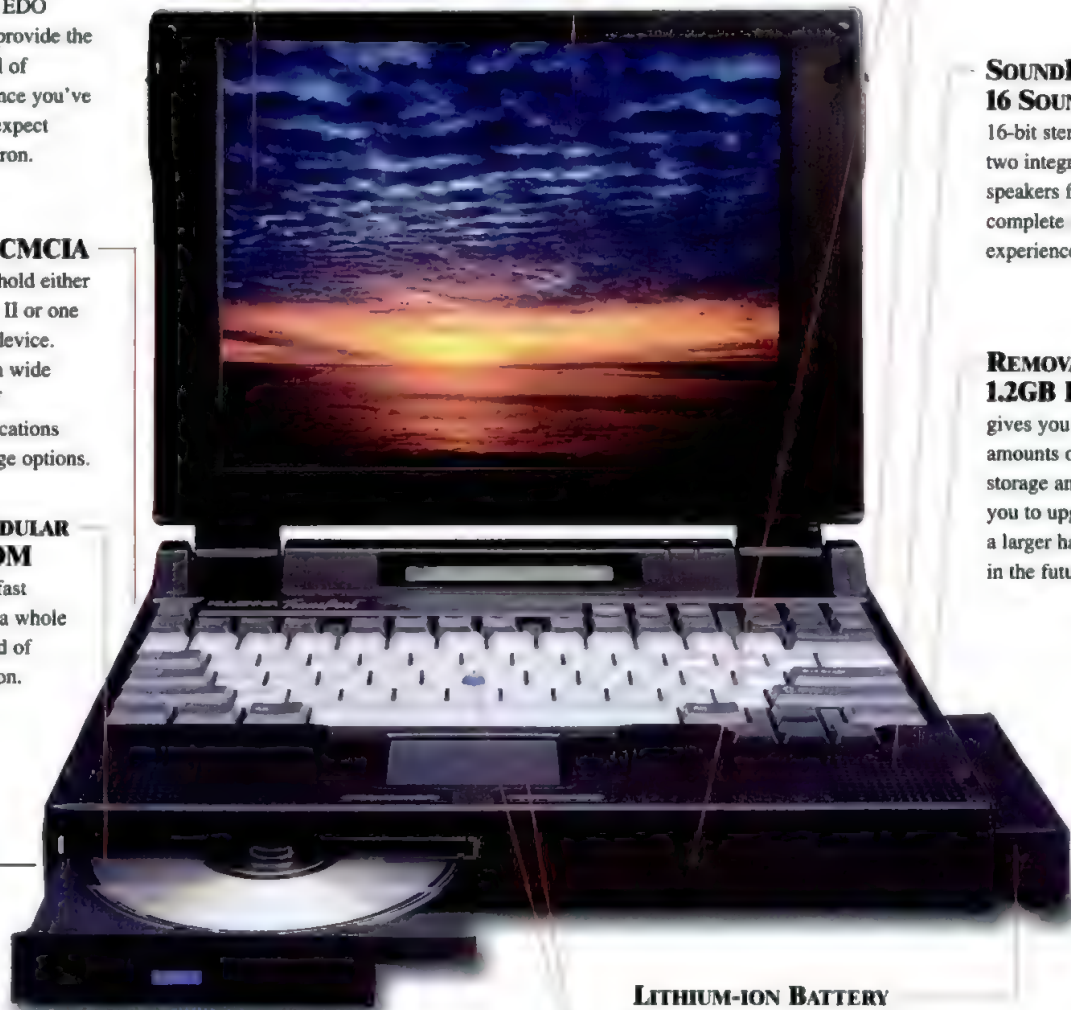
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—*Windows Sources*, April 1996

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—*PC Magazine*, April 9, 1996

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—*PC World*, March 1996

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—Windows Sources, April 1996



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- A** • 16MB EDO memory (48MB max.)
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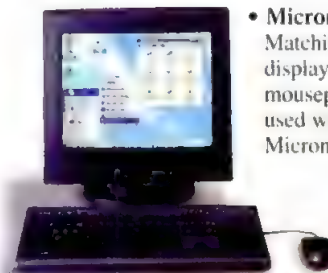
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TRANS-PCMG-96068

Winstone numbers. The units' 2.1GB Seagate hard disks led to average Disk WinMark 96 scores for both, while Plextor 6X CD-ROM drives aided in above-average CD-ROM WinMark 96 scores. The Number Nine Imagine 128 card with 4MB of VRAM in the Cobra P166 produced an above-average Graphics WinMark 96 score, while the Number Nine Motion 771 card with 2MB of VRAM in the Cobra P133 produced an average score.

Both PCs offer a three-year-parts, one-year-labor warranty with one year of on-site service. Three additional years of on-site service cost \$199.—*CM*

Cobra XLT/2 P133. Direct price: \$3,299. **Cobra XLT/2 P166.** Direct price: \$4,399. Robotech Inc., Midvale, UT; 800-255-2215, 801-565-0645; fax, 801-565-0680; <http://www.xmission.com>. Circle 477 on reader service card.

Royal Computer Inc.

Ultra Media Pro, Media 96 Pro

With its \$3,895 Media 96 Pro and \$2,395 Ultra Media Pro, Royal Computer offers an attractive pair of PCs for distinctly different audiences. The Pentium/133 Ultra Media Pro is a solid midrange or home-office choice and the Pentium 166 Media 96 Pro affords all-around adept performance to the power user. Royal also sells the Royal Media line of entry-level business machines; the Perfect Home Media line for the home user; the Imagine 128 Media workstations for graphics professionals; and the Media Master value line.



These two mini-tower PCs come with 512K of pipelined-burst L2 cache, a strong software bundle (including Infopedia 2.0, Perfect Office Pro, and Quicken SE for Windows), a 28.8/14.4-Kbps fax modems, 17-inch MAG monitors, and 16-bit Sound Blaster 32 PnP wavetable audio cards. The Ultra Media includes a set of MidiLand MLI-691 powered speakers; and the Media 96 offers an impressive set of Cambridge Soundworks speakers with a subwoofer.

Buoyed by an ATI Video Xpression

graphics card with 2MB of synchronous DRAM, the Ultra Media produced the top Graphics WinMark score in the Pentium/133 class. Aided by its 1.2GB Quantum Fireball EIDE hard disk, the unit posted average scores on all other tests. A TEAC CD-ROM drive was behind a low CD-ROM WinMark 96 score for a 6X drive, but it kept the Ultra Media in the middle of the pack.

The Media 96 performed similarly among Pentium/166 entries. With a 2.1GB Fast/Wide SCSI-2 hard disk, a Number Nine Imagine 128 graphics card with 4MB of VRAM, and a Toshiba 6X CD-ROM, it delivered slightly better than average scores on the majority of our tests.

These PCs include a one-year-parts and lifetime-labor warranty and limited live technical support. On-site service is available from a third-party vendor for the second through fourth years.—*CM*

Ultra Media Pro. Direct price: \$2,395. **Media 96 Pro.** Direct price: \$3,895. Royal Computer Inc., City of Industry, CA; 800-486-0008, 818-855-5077; fax, 818-330-2717; <http://www.royalcomp.com>. Circle 478 on reader service card.

S. A. G. Electronics

STA Dual 166 Ultra

S.A.G. Electronics' \$4,278 (direct) STA Dual 166 Ultra high-end business machine—also sold as a graphics workstation or a server because of its dual-processor-capable motherboard—turned in some of this roundup's best scores due to impressive, leading-edge components. S.A.G. also ships Alpha, Pentium Pro, and Quad Pentium machines. In our last Pentium roundup, S.A.G. received two Editors' Choice awards.

Using a single Pentium/166 CPU, Intel's new Triton II chip set, 512K of pipeline burst L2 cache, and a Tyan/S.A.G. dual-CPU motherboard, the STA delivered the number-three Winstone 32 score and a top-ten Winstone 96 score for its class. Thanks to a 4.3GB Fast/Wide SCSI-2 7,200-rpm hard disk, its Disk WinMark 96 score was superb, and a Number Nine Imagine 128 Series 2 graphics card



with 4MB of VRAM contributed to the highest Graphics WinMark score in our roundup.

The STA's core components are supplemented by a 17-inch Viewsonic monitor, a Sound Blaster AWE 32 wavetable audio card, and a Plextor 6X CD-ROM drive. By the time you read this, the machine will be shipping with a 2GB Ultra Wide SCSI hard disk.

S.A.G. backs this machine with a two-year parts-and-labor warranty. Round-the-clock on-site service can be had for \$70 per year.—*CM*

STA Dual 166 Ultra. Direct price: \$4,278. S.A.G. Electronics, North Andover, MA; 800-989-3475; fax, 508-689-0180. <http://sagelec.com>. Circle 479 on reader service card.

Summit Micro Design

Mount Olympus, Mount Shasta

Summit Micro Design's \$2,775 Mount Olympus and \$2,375 Mount Shasta provide a suitable arena for a face-off between Cyrix's 6x86 P166+ and Intel's Pentium. Although the Pentium/166-based Mount Olympus is aimed at high-end corporate users requiring network access and the 6x86-based Mount Shasta is sold as a standalone business PC, their core components are virtually identical. Both were strong performers in their 166-MHz class.

In both systems, the processor is supported by 512K of pipelined-burst secondary processor cache, Intel's Triton II chip set, a 1.2GB Quantum Fireball Fast ATA-2 hard disk, and a Diamond Stealth 64-PCI Video graphics card with 2MB of VRAM. Supplementing these components are a U.S. Robotics Sportster 28.8/14.4-Kbps data/fax modem, two ASUSTek speakers, and a 15-inch ADI monitor. The Olympus includes a copy of Microsoft Office Professional on CD-ROM; the Shasta includes Microsoft Office. The two differ in their sound cards as well: The Shasta used a 16-bit



Acer card with FM synthesis support, while the Olympus used a 16-bit FM synthesis Creative Labs model. A CardWare Labs 10/100 Fast Ethernet adapter is also included with the Olympus, which accounts for its higher price.

The Shasta produced an above-average Graphics WinMark 96 score, but otherwise both machines produced mostly average scores on our benchmark tests. Interestingly, the Cyrix-equipped Shasta posted higher scores than its Pentium-based sibling on every major test except our CPUmark measures.

The Shasta and the Olympus faltered only during our CD-ROM WinMark tests; the former's Mitsumi 4X CD-ROM drive contributed to one of this roundup's lowest scores. The latter's Creative Labs 6X drive fared only slightly better.

Summit Micro Design provides a three-year parts-and-labor warranty with these machines, and includes one year of on-site service.—*CM*

Mount Olympus. Direct price: \$2,775. **Mount Shasta.** Direct price: \$2,375. Summit Micro Design, Sunnyvale, CA; 800-288-5828, 408-739-6348; fax, 408-739-4643; <http://www.smd.hq.com>. *Circle 480 on reader service card.*

Swan Technologies Corp.

PowerHouse Deluxe 133, PowerHouse Deluxe 166

The \$2,573 PowerHouse Deluxe 133 and the \$2,923 PowerHouse Deluxe 166 represent Swan Technologies' flagship line of corporate PCs. Both machines boast attractive prices and performed on a par with their respective competition on most benchmark tests. Swan Technologies also offers the Swan Office Series for the corporate user who needs network connectivity and the Swan Family Series with enhanced multimedia capabilities.

Both Swan PCs came similarly equipped, with 256K pipelined-burst L2 cache, a 1.6GB EIDE hard disk and an STB Powergraph64 graphics accelerator card with S3's Trio 64V+ chip set and 2MB of EDO DRAM. Using these components, both machines turned in mostly average benchmark test scores in their



processor classes. One exception was the PowerHouse-P166's below-average Graphics WinMark 96 result. The PowerHouses also garnered very low CD-ROM WinMark 96 scores, because of their Lxycon 6X CD-ROM drives, whose access times were slower than average.

Both machines include a 15-inch monitor, a 16-bit Televideo sound card, and a software bundle that features Microsoft Encarta, Microsoft Office Pro, and seven popular multimedia titles.

All Swan lines come with a one-year parts-and-labor warranty that includes on-site service.—*CM*

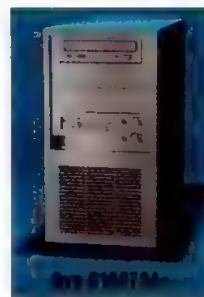
PowerHouse Deluxe 133. Direct price: \$2,573. **PowerHouse Deluxe 166.** Direct price: \$2,923. Swan Technologies Corp., Marlborough, MA; 800-533-1131, 508-460-1977; fax, 508-480-0156; <http://www.swantech.com>. *Circle 481 on reader service card.*

Sys Technology Inc.

Performance P133T2A, Performance C166T2A+

Sys Technology's entries in our roundup include its high-end \$2,759 (direct) Sys Performance C166T2A+ and its \$2,329 (direct) Sys Performance P133T2A. Both machines scored well on our benchmark tests, but the Pentium/133-based Sys P133T2A may represent the better value, putting up numbers that equal many of the higher-end PCs. The Performance line, which also includes Pentium Pro units, targets the corporate, government, and institutional markets as well as small- and home-office power users. Sys also offers a value line.

The Sys C166T2A+, featuring the new Cyrix 6x86-P166+ processor and the new Intel Triton II chip set, posted average scores on all of our tests. The Sys P133T2A also has a Triton II chip set, but it is based on a Pentium/133 CPU. It garnered above-average marks on our Winstone 96, Graphics WinMark 96, and CD-ROM WinMark 96 tests, and solid scores on our Winstone 32 and Disk WinMark 96 tests. The above-average graphics result can be attributed to the Matrox MGA Millennium graphics card with 2MB of WRAM (also used in the Sys C166T2A+). The Sys P133T2A's



test scores, when measured against the high-end PCs in this review, place it within the average range. Its CD-ROM WinMark score was above the average within this field.

For CD-ROM drives, Sys includes a TEAC 6X model with the Sys P133T2A; while the Sys C166T2A+ uses a Toshiba 6.7X SCSI CD-ROM drive.

Sys offers a one-year-labor warranty with the units. System pieces are covered according to the individual warranties of the original component manufacturers. On-site service is \$95 for the first year.—*David Lidsky*

Performance P133T2A. Direct price: \$2,329. **Performance C166T2A+.** Direct price: \$2,759. Sys Technology Inc., Cypress, CA; 800-613-9963, 714-821-3900; fax, 714-821-9592; <http://www.systechology.com>. *Circle 482 on reader service card.*

Tagram System Corp.

Thunderbolt Office Station P-133, Thunderbolt Virtual Studio P-166

Tagram System's \$2,095 Thunderbolt Office Station P-133 and \$2,445 Thunderbolt Virtual Studio P-166 deliver what their marketing sheets promise. The Thunderbolt Office Station P-133, a midrange system for corporate peer-to-peer networks, provides strong performance within its class at an attractive price. The Thunderbolt Virtual Studio P-166 is a high-end multimedia workstation that offers a particularly strong graphics subsystem and competitive performance in other areas. Tagram also ships Ultimate MPC and Home Theatre lines for multimedia users, a Desktop Publishing line, and a Corporate P6 line of Pentium Pro systems.

Using 256K of pipelined-burst external cache, the Virtual Studio turned in average scores on CPUmark tests and both types of Winstone tests. A 1.2GB Quantum Fireball hard disk and a TEAC 6X CD-ROM contributed to average Disk WinMark and above-average CD-ROM



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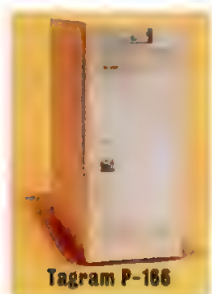
What else would you expect? We live and breathe network engineering.

For detailed specs, visit http://www.hp.com/go/network_city. Or call 1-800-533-1333, Ext. 1615.

WinMark scores, respectively. But the Virtual Studio's true strength surfaced during our graphics tests: A Matrox Millennium graphics card with 2MB of VRAM was responsible for an impressive Graphics WinMark score.

The midrange Office Station performed similarly in the 133-MHz class. Intel's new Triton II chip set, 512K pipelined-burst cache, a 2GB Seagate IDE hard disk, and a TEAC 6X CD-ROM drive aided in average Winstone 32, Winstone 96, Disk WinMark, and CPUmark scores, and an above-average CD-ROM WinMark score. A Number Nine Imagine 128 graphics card with 2MB of VRAM lead to a higher-than-average Graphics WinMark score.

Both systems also included MAG monitors (a 15-inch screen for the P-133 and a 17-inch for the P-166), Creative Labs 16-bit sound cards, and two stereo speakers.



Tagram P-166. Direct price: \$2,445. Tagram System Corp., Tustin, CA; 800-824-7267, 714-258-3222; fax, 714-258-3220; <http://www.tagram.com>. Circle 483 on reader service card.

Tangent Computer Inc.

MediaStar 5133, MediaStar 5166

With unique, easily accessible case design and strong benchmark test scores, the \$2,195 Tangent MediaStar 5133 and the \$3,095 Tangent MediaStar 5166 from Tangent Computer offer a good combination of features and speed. The MediaStars are built for those interested in a multimedia-capable PC.

Tangent's desktop case design makes the multimedia features of the MediaStars as easy to use as any stereo system. The volume dial and bass controls are on the front of the system. Opening a front panel reveals a game/MIDI port, line in/out and RCA in/out jacks. The case also features two integrated speakers.



Both MediaStars use EDO DRAM, 512K of L2 cache, and 1.2GB Quantum Fireball hard disks. The major internal component difference between the two is the graphics adapter: The MediaStar 5166 came with a Matrox Millennium board and the MediaStar 5133 offers a STB Powergraph 64 adapter. The MediaStars were average performers on our benchmark tests, except for the MediaStar 5166's below-average CD-ROM WinMark 96 score.

The MediaStar 5166 ships with an 8X CD-ROM drive and a 17-inch Sampo Alphascan monitor; the MediaStar 5133 has a 6X CD-ROM drive and a 15-inch Alphascan monitor. Tangent bundles Dragon Dictate, Novell's Perfect Works Phone Disc, and Quicken 4.0 with both PCs.

The Tangent MediaStars are accompanied by three-year parts, labor, and on-site service warranties.—CL

MediaStar 5133. Direct price: \$2,195. **MediaStar 5166.** Direct price: \$3,095. Tangent Computer Inc., Burlingame, CA; 800-826-4368, 415-342-9388; fax, 415-342-9380; <http://www.tangent.com>. Circle 484 on reader service card.

Tatung Co. of America

Tatung TCS-5100, Tatung TCS-5900

Tatung Co. of America's \$2,195 TCS-5100 and \$2,795 TCS-5900 are part of its UNIQ line of modest, inexpensive machines for corporate users. Both offer attractive prices and 15-inch Tatung monitors with integrated speakers; and both kept pace with their respective competition on our benchmark tests.

The TCS-5100 is centered on a Pentium/133 processor; the TCS-5900 is based on a Pentium/166 CPU. Both sys-



tems were built with Tatung motherboards, Triton chip sets, and 256K pipelined-burst external caches; as a result, they delivered average scores in their respective classes on our Winstone 32, Winstone 96, and CPUmark tests. Diamond Stealth64 graphics cards with S3's Vision968 chip set and 2MB of VRAM aided in average Graphics WinMark 96 scores; 1.2GB Quantum Fireball hard disks helped in average Disk WinMark scores. With their proprietary 6X CD-ROM drives, however, both machines turned in relatively low CD-ROM WinMark scores.

Neither machine offered bundled software. Both systems do include 16-bit Creative Labs sound cards, however, and plenty of room for expansion.

Tatung includes a one-year parts-and-labor-warranty. On-site service costs \$30 for the first year.—CM

TCS-5100. Direct price: \$2,195. **TCS-5900.** Direct price: \$2,795. Tatung Co. of America, Long Beach, CA; 800-829-2850, 310-637-2105; fax, 310-637-8484; <http://www.tatung.com>. Circle 485 on reader service card.

Unisys Corp.

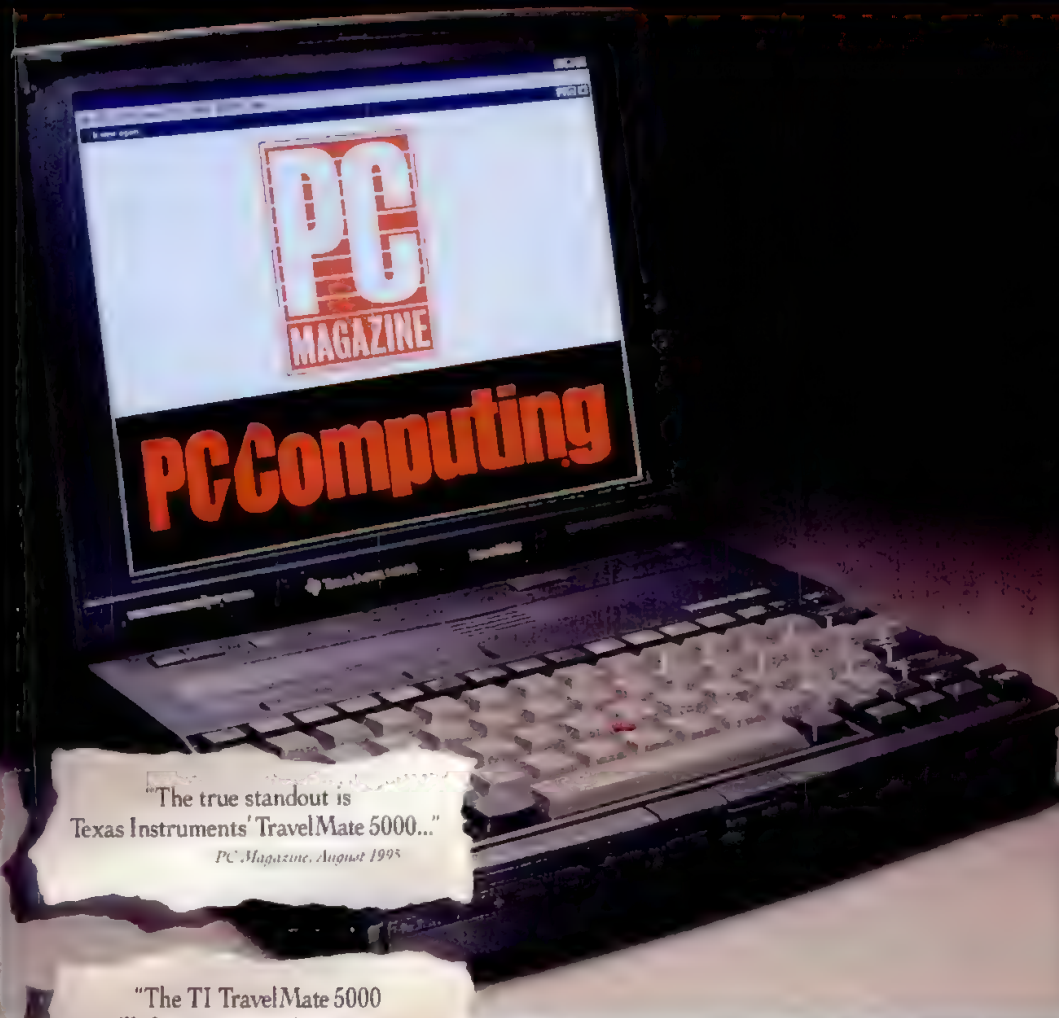
Unisys CWP-51333, Unisys CMT-51667

The \$2,579 133-MHz Unisys CWP-51333 and the \$4,010 166-MHz Unisys CMT-51667, both part of the PW2 Advantage Series from Unisys Corp.'s PC Division, pack good components and features. But they posted disappointing test scores. The Unisys CWP-51333 slimline is marketed as a ready-to-go midlevel office workstation; the Unisys CMT-51667 mid-tower is more of a power system, offering ample expansion room.

The Unisys CWP-51333 was the only system in this roundup with an ALi PCI chip set on its Acer motherboard. (Most others used Intel's Triton or Triton II chip sets.) This motherboard offers IrDA-compliant infrared support, an integrated 64-bit Cirrus Logic GD5436 graphics chip set



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with 2MB of DRAM, and a 10-Mbps Ethernet interface that is activated when a special LAN card (not included) is inserted in a proprietary expansion slot. The unit's three drive bays were all occupied.

The Unisys CMT-51667 came with a Number Nine Vision 330 graphics board with 2MB of DRAM. Though its Triton-based Unisys motherboard offers integrated IDE connectors, it was configured with a 1GB Fast/Wide SCSI-2 Fujitsu hard disk and an Adaptec AHA2940 SCSI-2 adapter.

Both PCs came with Creative Labs 16-bit sound boards and Sound Blaster SB38 speakers. Both also had Unisys monitors (a 15-inch with the CWP-51333 and a 17-inch



Unitek Skyraider

corporate and government buyers.

Equipped with 256K pipelined-burst L2 cache and a Number Nine Imagine 128 graphics card with 2MB of VRAM, this machine posted average scores on our Winstone 96, Winstone 32, and Graphics WinMark 96 tests. The Skyraider's only stumbling block was the Disk WinMark test: It posted a below-average result mainly because of its 5,200-rpm 1.6GB EIDE hard disk, which had to compete mostly against 5,400-rpm and faster disks.

The Skyraider's desktop case features well-labeled ports. The system is also DMI-compliant, and provides setup software. A 16-bit Creative Labs wavetable sound card, Funai 6X CD-ROM drive, two stereo speakers, and a Viewsonic 17-inch monitor with integrated speakers are welcome additions to this package.

Unitek Technology provides a one-year warranty with the Skyraider. On-site service can be obtained for an additional \$75 per year, and technical support is available from 8:00 to 5:00 weekdays and from 10:00 to 3:00 Saturdays (Pacific time).—*CM*
Skyraider. Direct price: \$2,695. Unitek Technology Inc., Ontario, CA; 800-944-5650, 909-930-5700; fax, 909-930-5710. Circle 487 on reader service card.

USA Flex

Flex PT133 Multimedia Special

The Flex PT133 Multimedia Special (\$2,249 direct) from mail-order vendor USA Flex is an excellent family or small-office/home-office PC offered at a great price. Performance was competitive with its 133-MHz CPU class, and the system's software bundle and features make it a superb bargain.

SERVICE & RELIABILITY

USA Flex

Reliability	Average
Repair	Average
Technical support	Average
Percent needing repair	Worse than average

Internal components include an STB Powergraph 64 graphics adapter based on the S3 Trio64V+ chip set and a 1.5GB Western Digital hard disk. On our benchmark tests, the Multimedia Special posted average scores in its CPU class.

The Multimedia Special's Intel Endeavor motherboard offers built-in FM synthesis sound support; to this, USA Flex adds an optional wavetable-capable riser card (included in the above price). Other multimedia features include a 6X CD-ROM drive and Micro Innovations MM40P stereo speakers. For the gaming enthusiast, USA Flex includes a joystick and several CD-ROM game titles.

Among the many software titles bundled with the machine are Body Works, Family Doctor, Compton's Multimedia Encyclopedia, and Novell's Perfect Office. For the novice PC user, USA Flex includes a setup poster, labeled ports and a Getting Started video. The vendor completes the package with a 28.8/14.4-Kbps fax modem and a 15-inch monitor.

USA Flex includes a three-year-parts and lifetime-service warranty. Technical support is available 24 hours a day, 7 days a week. A one-year on-site warranty is \$49. There is also a 30-day money-back guarantee.—*CL*

Flex PT133 Multimedia Special. Direct price: \$2,249. USA Flex, Bloomingdale, IL; 800-872-3539, 708-582-6206; fax, 708-351-7204. <http://www.usaflex.com>. Circle 488 on reader service card.

US Computer Direct

Freedom LX+, Patriot LX+

US Computer Direct's two Pentium 166-based PCs—the \$2,349 Freedom LX+ and the \$2,799 Patriot LX+—are aimed at distinctly different audiences. The Patriot is the vendor's high-end desktop offering, while the Freedom is targeted at the value-conscious buyer. The differences between the two are few, and their scores on our benchmark tests were nearly identical: Both performed on a par with their



SERVICE & RELIABILITY

Unisys Corp.

Reliability	Worse than average
Repair	Average
Technical support	Average
Percent needing repair	Average

with the CMT-51667), and Toshiba 4X CD-ROM drives (an IDE model on the CWP-51333 and a SCSI-2 on the CMT-51667).

The Unisys pair scored at or near the bottom of their CPU classes on all of our tests. The CWP-51333's use of asynchronous cache instead of faster synchronous cache affected its processor scores, which in turn affected all other test results. The CMT-51667 had a 64-bit graphics accelerator and a 5,400-rpm hard disk, but in a field using speedier graphics engines and 7,200-rpm hard disks, it had difficulty keeping pace.

These units have a three-year warranty with a year of on-site service.—*RSA*
Unisys CWP-51333. Street price: \$2,579.
Unisys CMT-51667. Street price: \$4,010. Unisys Corp., PC Division, San Jose, CA; 800-874-8647, 408-434-2848; fax, 408-434-4844; <http://www.pc.unisys.com>. Circle 486 on reader service card.

Unitek Technology Inc.

Skyraider

The 166-MHz Pentium-based Skyraider from Unitek Technology is a representative of the vendor's custom-built line of desktops and mini-towers. This machine stacked up well against the competition on the majority of our benchmark tests, and its attractive price of \$2,695 should appeal to its target market of high-end

166-MHz competition on all measures.

There are only two significant component differences between these two units:



The Patriot is equipped with 512K of pipelined-burst L2 cache and a 1.6GB Western Digital hard disk, while the Freedom is outfitted with 256K L2 cache and a 1.2GB Quantum Fireball hard disk.

Both machines utilize Diamond Stealth64 graphics adapters with 2MB of VRAM and 6X CD-ROM drives. This lineup is further enhanced by 28.8-Kbps full-duplex data/fax/voice modems with voice-mail, speakerphone, and caller ID support. The Patriot has a 17-inch MAG monitor, and the Freedom has a 15-inch MAG monitor.

Both US Computer PCs are backed by a two-year-parts warranty and a lifetime-labor warranty. On-site service is \$59.95 for one year.—CM

Freedom LX+. Direct price: \$2,349. **Patriot**

LX+. Direct price: \$2,799. US Computer Direct, Huntington Beach, CA; 800-787-4947, 714-841-4081; fax, 714-841-4262; <http://www.us-computer.com>. *Circle 489 on reader service card.*

Vektron

Optima Station P133, Power Pro P166

If you're looking for a PC with top-notch hardware offered at a competitive price, Vektron may have a machine for you. The \$2,295 Optima Station P133 and the \$4,495 Power Pro P166 (direct prices), members of Vektron's Power PC line, target general corporate and small-office/home-office users. The Power Pro is designed to appeal to the power users within those markets.

The Power Pro offers a 4GB Seagate Fast/Wide SCSI-2 hard disk, a 17-inch MAG monitor, a 28.8/14.4-Kbps V.34 modem, and Yamaha M10 speakers with a subwoofer. The Optima Station bundles these same components, but pares them back to a Seagate 2GB EIDE hard disk, a 15-inch monitor, and the same

speakers without the subwoofer. The units feature Matrox MGA Millennium graphics cards with 2MB of WRAM, Creative Labs Sound Blaster 32 wavetable sound cards, and Microsoft Office Professional 95.

Both PCs delivered average test results; the notable exception was the Power Pro's above-average score on the CD-ROM WinMark test, thanks to its Toshiba 6.7X SCSI CD-ROM drive.

Vektron provides a four-year parts-and-labor warranty; on-site service is \$50 for the first year.—DL

Optima Station P133. Direct price: \$2,295.

Power Pro P166. Direct price: \$4,495. Vektron, Grand Prairie, TX; 800-659-9523, 214-606-0280; fax, 214-606-1278; <http://www.vektron.com>. *Circle 490 on reader service card.*



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Coming to Terms with 3-D

1• ANTI-ALIASING is a technique used to make edges appear smooth by blurring pixel edges to eliminate jaggies.

2• ALPHA BLENDING enables two images to be blended together. This allows atmospheric effects such as fogging (blending with a translucent image that obscures the image) and depth cueing (lowering the intensity of lighting to make the object appear more distant from the viewer).

3• BILINEAR AND TRILINEAR FILTERING smooth flat surfaces, such as walls that move linearly away from the viewer.

4• DOUBLE BUFFERING indicates that the graphics engine employs two buffers—one for display and the other for rendering. The viewer then sees only the finished screen image and not the rendering process, which results in smooth-motion animation.

5• FLAT SHADING is the most basic shading technique, where an entire triangle consists of a single color. Flat shading creates a blocky effect over an image, because there's no blending of colors.

6• GOURAUD SHADING is a more advanced shading method that analyzes the color at each triangle corner and averages the value over each pixel in the polygon. This improves overall appearance by blending colors within each polygon.

7• PERSPECTIVE CORRECTION correctly alters textures in a scene to give a real sense of convergences as continuous elements, such as a brick wall, get farther from the viewer.

8• TEXTURE MAPPING pastes bitmapped texture images stored in memory to triangle surfaces, almost like wallpaper, to add another level of realism.

3-D

COMES ALIVE

3-D graphics acceleration is coming to mainstream personal computers, and it's not just for game players.

Like clockwork, each summer and fall the average PC user is confronted by a new technology that upsets the carefully constructed purchasing models from the previous year. This year it's mainstream three-dimensional graphics, a promising technology burdened with a particularly obscure set of jargon and boatloads of market hype. When it delivers what it promises, desktop 3-D will be the dawning of a new age, a technology combining the technological sophistication of a high-end workstation with the enjoyment potential of an arcade game, all from your workaday PC.

For the most part, the 3-D graphics chip revolution has not affected the high-end 3-D boards like those tested in the accompanying roundup. These boards, used by professionals for modeling and CAD, rival workstation performance with dedicated 3-D silicon and sockets for at least 4MB and as much as 24MB of RAM. They also support higher-level pro-

By Jan Ozer



• **MIP MAPPING** (for *multum in parvam*, or many in few, not millions of instructions per second) stores copies of the bitmap that makes up the texture in different sizes within memory to minimize distortion caused by shrinking or enlarging textures during perspective correction.

• **RENDERING (OR SHADING)** describes how color is distributed on the individual triangles.

• **Z-BUFFERING OR HIDDEN SURFACE REMOVAL** tracks the depth of each triangle from the viewer's perspective to ensure that objects that fall behind others in a scene do not get drawn to the screen but do appear as the viewer moves within a scene.

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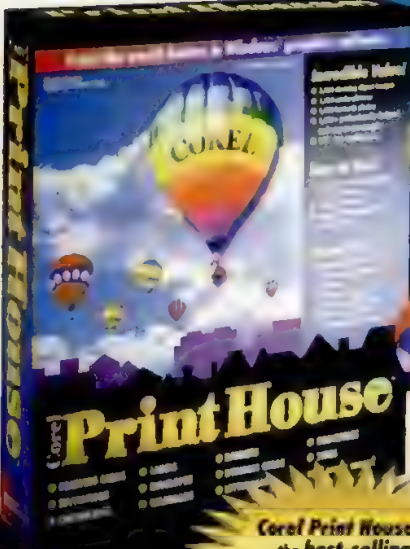


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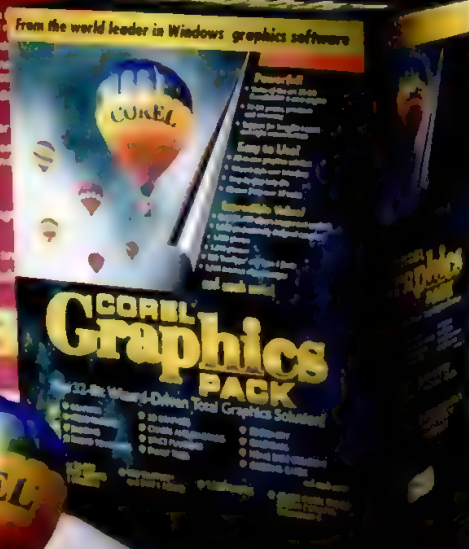
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HIGHLIGHTS

High-End Graphics Boards

3-D is on the verge of becoming a standard for mainstream graphics accelerator boards. With the emergence of Microsoft's Direct3D API and a bevy of new 3-D-capable, low-cost chip sets, developers of games, business software, and VRML Web browser plug-ins are using 3-D graphics with ever-increasing frequency.

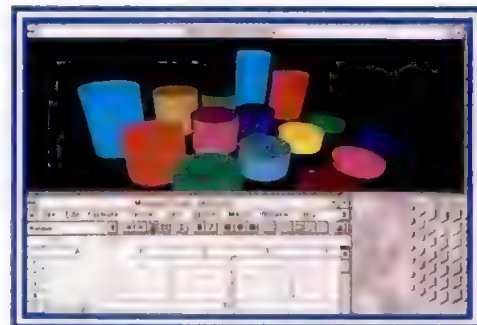
With the introduction of Direct3D, Microsoft significantly advanced the ascension of 3-D into the mainstream. This Windows 95 API provides a standard platform through which 3-D software can interact with 3-D hardware, so developers no longer have to write individual drivers for each divergent chip set on the market. This will benefit PC gamers by delivering more realistic environs, as well



as business users by allowing applications to deliver information in a more intuitive format.

Graphics professionals care less about the 3-D worlds;

they need graphics accelerators that deliver rock-solid images at very high resolutions. The high-end 2-D boards here are aimed at graphic artists, DTP users, and 2-D CAD/CAE designers. For these tasks you'll need a board with at least 4MB of RAM that can deliver high refresh rates (from 80 Hz to 100 Hz or more) at the screen resolutions and color depths you work in.



OpenGL 3D is a whole different game. These ultra-high-end accelerator cards adhere to SGI's OpenGL standard, which ensures accurate rendering of 3-D objects. Unlike in games and traditional business applications, users at this level need exacting accuracy in addition to high frame rates for chores such as 3-D modeling, virtual reality, and 3-D design. Some may recall these boards costing as much as \$30,000, but now they can be purchased for much less.

programming interfaces like SGI's OpenGL and Autodesk's Heidi, which are largely irrelevant to the business user or gamer. We review ten OpenGL-compatible high-end boards in the accompanying story. But such boards sell for \$1,000 and up, hardly the type of hardware you will find in a typical business machine. We also review seven 2-D boards representing the higher end of the mainstream—\$400 to \$600 boards aimed at graphics professionals and power users who want to maximize 2-D GUI performance.

For mainstream PC users, meanwhile, 3-D APIs are coalescing, chips are launching in droves, and application support is booming, perhaps most conspicuously in

the games arena but increasingly in business applications as well. The earliest 3-D-capable boards aimed at this market, which were released in time for Christmas last year, generally left users wanting. They found that the 2-D graphics acceleration they were used to for their GUI operating environments was not what they had come to expect from dedicated 2-D boards, and these early adopters also found application support slow in coming.

Those two shortcomings should be rectified by this Christmas. It's a safe bet that 3-D graphics capabilities for games and business applications, along with robust 2-D acceleration, will soon become standard features in mainstream graphics

cards that cost less than \$200.

The first 3-D accelerators hit the PC market in mid-1995, primarily in the form of products like the Diamond EDGE 3D, which let users play game-console-style games on their computers. While most early 3-D applications were games, business support is steadily growing. 3-D is being integrated into most presentation and authoring programs, while spreadsheets that give you a three-dimensional view of data and even 3-D user interfaces (perhaps Bob 3-D?) are in the works.

We're starting to see virtual 3-D worlds as database front ends, allowing computer novices to view network configurations in remote offices by selecting a city from a spinning globe. Netscape's acquisition of VRML vendor Paper Software and widespread availability of VRML browser plug-ins forecast 3-D's popularity on the Web as well. While it's safe to assume that 3-D's Web presence will initially be dominated with dreary spinning logos, more advanced Web pages are already enabling "virtual worlds," offering each visitor a unique experience.

WHAT IS 3-DP

3-D chips work with the host CPU to enable computers to generate realistic and

IN THIS REVIEW

2-D GRAPHICS ACCELERATORS:

ATI Graphics Pro Turbo	182
Diamond Stealth64 Video	182
ELSA Winner2000 Pro/X4	184
Hercules Terminator Professional	189
Metrox Millennium	190
Number Nine Imagine 128	192
Number Nine Imagine 128 Series 2	192
Summary of Features	189

3-D GRAPHICS ACCELERATORS:

AccelGraphics AccelR8	192
-----------------------------	-----

Diamond FireGL	194
Dynamic Pictures V192 Graphics Accelerator Module	194
ELSA GLoria 8	199
Fujitsu Sapphire 2SX; 3D Designer	200
Ok! Triangl 16P; 24P	202
OmniComp 3Demon SX88	203
Symmetric GLyder 16	203
Performance Tests	196
A Peek into the 3-D Domain	200
Summary of Features	202

High-End Graphics Boards

lifelike graphics much faster than the CPU could render them alone.

All 3-D images are created in the so called the 3-D Graphics pipeline, which has two stages. First is the *geometry stage*, where the vector graphics information behind the 3-D image and backgrounds is processed as triangles readily manipulated by the computer. The second stage, usually handled by a 3-D processor, is *rendering* (or *shading*), where the polygon information is converted to pixels for display. *Naked triangles* are fairly coarse and unlikelike, causing developers to seek more advanced functions to enhance appearance. These break down into four general categories: shading, texture mapping, atmospheric effects, and hidden surface removal, as described in the accompanying illustration. Each of these effects must be implemented during the geometry phase, then drawn before display.

These techniques—Gouroud shading, texture mapping, alpha blending, and so on—add significantly to the realism of the image, but also to its complexity. For the most part, a Pentium-class machine can manage the geometry side of fairly sophisticated effects without slowing down, but only if a 3-D graphics accelerator assists during rendering.

MARKET SEGMENTATION

What started as an unorganized melange of 3-D chip announcements is also falling into recognizable categories and markets: 3-D-only chips that require a separate 2-D graphics processor, integrated graphics chip sets that add 3-D functionality to existing 2-D and video acceleration features, and super-integrated chips that add features like audio, digital input support, and data and fax modem capabilities.

Undeniably, the origins of the PC 3-D market are in arcade games, and a category of high-performance, specialty featured products will emerge to serve this market segment. These products, which will ship as standalone 3-D accelerators and integrated graphics solutions, will

generally be too expensive for the cost-sensitive mainstream marketplace. For example, Diamond's EDGE 3D, based on the nVidia chip set, costs \$100 more than Diamond's Stealth 3D 2000, based on S3's ViRGE chip set. However, the nVidia chip set enables wavetable sound, digital joystick input, and supports SEGA game pads, coming close to or even exceeding the arcade experience.

Also competing in this market are NEC/VideoLogic with its PowerVR chip, which will soon appear on sub-\$200 3-D accelerators; the Voodoo 3D chip set from 3Dfx; and an unnamed integrated chip set from Cirrus Logic that integrates technology licensed from 3DO.

Most mainstream graphics card and computer vendors will introduce 3-D into their product lines this summer, probably at a small price premium over 2-D-only systems. These boards will use chips such as S3's ViRGE, Matrox's MGA-1064SG, and ATI Technologies' 3D Rage, which stress price/performance over the complete range of graphics functions. A little higher on the price continuum, Number Nine will weigh in with its Imagine 128 Series 2 chip set, which should adeptly combine 2-D and 3-D functionality. Boards based on the Series 2 may cost around \$650. A bevy of veterans and newcomers are also targeting this market, primarily claiming superior performance (3D Labs Permedia, Oak OTI-64311, Rendition Verité) or features like video-out (Triton T3D9695), which lets the graphics card connect to a television. Competing for space on the motherboard is Chromatics Mpack' media engine, which combines 2-D and 3-D graphics, fax/modem, and audio functionality, along with MPEG-1 compression and decompression and MPEG-2 decompression.

DIRECT 3-D

3-D application support is nascent, primarily because of the lack of a standard application programming interface (API) tying 3-D hardware and software together. Without an API, applications seeking 3-D hardware acceleration for games and other non-OpenGL-level 3-D were forced to write discrete drivers for each supported chip set, a burden for even the largest developer.

This created the now-familiar dynam-

ic wherein hardware developers sought to gain a franchise by convincing software developers to develop programs supporting their proprietary API. As usual, the lack of a stable installed base stifled third-party development, as most software developers declined to support any API without a

high-volume bundling agreement to fund the development.

Into this vacuum stepped Microsoft with its March 1996 announcement of the Direct3D API, the last component of the DirectX series of Windows 95 I/O APIs. Architecturally, Direct3D provides high- and low-level APIs for software developers and a hardware abstraction layer that interfaces with drivers written by the 3-D chip vendors. Direct3D is tightly integrated into DirectDraw, enabling combined, bitmapped 3-D and video effects, like playing back video on the faces of a spinning cube.

Functionally, the high-level API includes 3-D functions such as "geometry engines" and object database routines that developers would otherwise have to write or license. The low-level API lets developers of fast-twitch games use their own optimized code and call more specific hardware functions to maximize overall program speed. Direct3D also provides software emulation of 3-D functions, querying the graphics chip set to determine its capabilities and dynamically allocating work between CPU and 3-D chip to maximize overall performance.

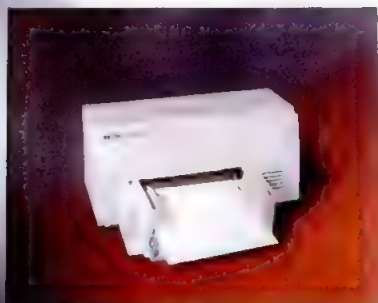
Direct3D was immediately embraced by over 80 industry vendors, including vir-



Our Contributors: JAN OZER is a frequent contributor to *PC Magazine*. JON HILL, a former project leader at the magazine, is also a frequent contributor. LINDA and ERICK VON SCHWEBER are principles of Infomaniacs, a thinktank in Sedona, Arizona, specializing in the convergence of 3-D, multimedia, databases, and the Web. JAMIE M. BSALES was the associate editor in charge of this story, and JEFF MACE was the project leader.



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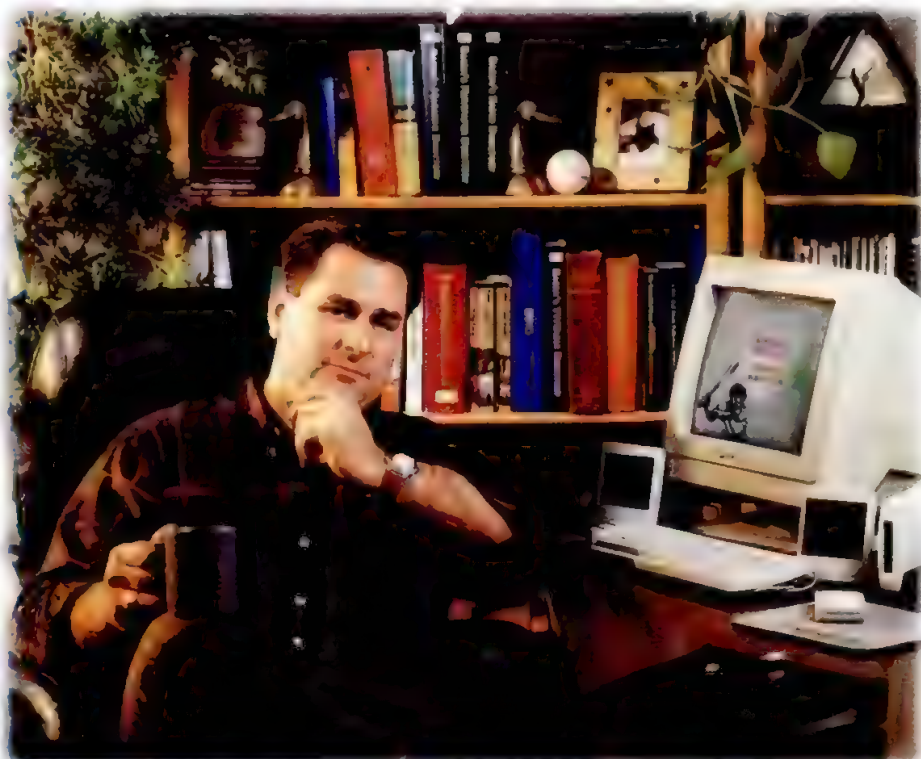
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tually all 3-D chip vendors. The only serious competition comes from Apple's QuickDraw 3D Rave, which provides similar functionality. Microsoft has an early lead in third-party support, and will probably emerge as the API winner.

What about Windows 3.11 and DOS? By now, most business software developers have largely abandoned Windows 3.11 development with 3-D support. Game developers will probably also soon abandon these legacy platforms, since Direct3D provides the hardware access necessary for optimal program speed, and because most 3-D accelerators will likely be sold into Windows 95 systems.

ANALYSIS

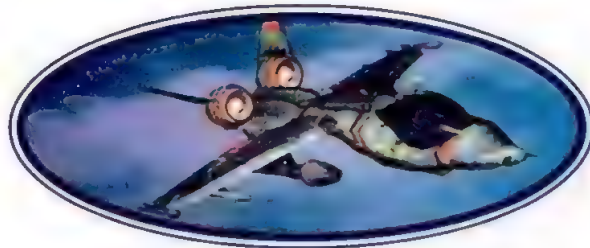
All of which is not to say that measuring 3-D chip performance is a simple matter. A quick scan of 3-D chip specs and home pages reveals two emerging benchmarks: pixels per second and triangles per second. Muddying the picture further, most games monitor performance by a third metric, frames per second (fps).

While seemingly objective, all three measures vary greatly depending upon host CPU, screen resolution, color depth, and in the case of triangles per second, enabled features and triangle size. For example, a flat shaded triangle renders much faster than a Gouraud-shaded, perspective-corrected, trilinear MIP-map textured and fogged triangle. These factors combine to make the benchmark test scores cited by the various vendors largely incomparable.

To a significant degree, Direct3D insulates most corporate buyers from the risks associated with buying 3-D hardware: As long as the board supports the new specification, it should work with all new Direct3D applications. For gamers, the short term result is not so clear, as high-volume chip vendors continue to seek ports to their APIs for not only for Windows 3.11 games, but for Windows 95 as well. All of the games developers we contacted intend to support Direct3D once it is shipped and stable. Some will drop all proprietary support, while others intend to continue if it provides a performance advantage.

3-D graphics for the masses is almost here. We're seeing the hardware and compelling software that will make 3-D support in your next graphics card worth the price of admission.

The High & Mighty



Accelerator cards are also getting better and cheaper for graphics and CAD professionals. Here are the best 2-D and 3-D offerings.

By Jeff Mace

Impressive as the coming wave of mainstream Direct3D accelerators may be, those boards will not address the needs of graphics and CAD professionals. So in the following two sections we review the fastest 2-D and 3-D high-end graphics accelerator boards available for the PC.

If you're designing or managing Web pages, editing scanned images or creating your own art, doing in-house desktop publishing, and working in a variety of graphics packages, you need a robust 2-D graphics display adapter. This means at least 4MB of display memory, plus a fast RAMDAC capable of driving your monitor at high refresh rates for flicker-free display at resolutions higher than 800-by-600 at a 24-bit color depth (also called true color). They'll provide significantly more graphics horsepower than the graphics adapters found on many mainstream business PCs.

2-D REVIEW CRITERIA

To be eligible for inclusion in our first review section, a board had to be a production-level shipping product with FCC

Class B certification, 4MB of frame buffer RAM, stable Windows 95 drivers, and the ability to achieve a vertical screen refresh rate of 75 Hz or better at 1,152-by-864 resolution. Since these products are aimed at image-editing and other graphics professionals, they also had to include color-calibration utilities. Unlike mainstream graphics cards, which generally cost less than \$200, boards in this realm sell for about \$500 on the street as of April 15.

Our research turned up seven products from six leading vendors: ATI Technologies, Diamond Multimedia, ELSA, Hercules, Matrox Graphics, and Number Nine Visual Technologies. (STB Systems was readying a 4MB version of the Lightspeed 128, though it was not available in time for testing.) Most of these products are mature entries that have been around for over a year. What is new across the board, however, is that each of these products feature *optimized* Windows 95 drivers and more complete integration into the Windows 95 interface.

With Windows 95's reengineered graphics subsystem, a particular technique for speed optimization has come to

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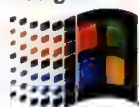


between fax and voice calls, has fax on demand and identifies callers before you pick up. WM And there's more. Built-in compression cuts fax transmission time (and phone bills) by up to one-third. It now supports gray-scale faxing, integrates with Microsoft® Exchange, and includes OCR, 101 ready-to-use fax cover sheets and tools to design your own.

WM You can even get WinFax PRO as part of new Delrina CommSuite™ 95, the complete, affordable, integrated communications software solution for Windows 95. WM All of which should suffice until the new alpha wave faxing program is ready. (Hmm. Perhaps if we *partition* your brain so that one half can receive faxes while the other remains undisturbed...) **DELIRINA**

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Windows 95

your computer into an integrated in-box for faxes, e-mail and voice mail. It even takes phone messages, distinguishes

our attention. This technique bypasses a portion of the GDI (Graphics Device Interface) by patching certain graphics calls and routing them for immediate access by the graphics hardware. While we are awaiting response by Microsoft, which has certain conformance requirements for Windows 95 logo certification, we know from testing that this approach gives a performance edge to vendors who use it (in this review, the Matrox Millenium; see the Benchmark Tests section for details).

In addition to increased performance, the new Windows 95 drivers mean better union with the Windows 95 user interface. Ease-of-use features abound: Many of the boards now offer tight integration into the Display Properties box, right-mouse-click access to features, and the ability to change modes and settings on the fly.

3-D REVIEW CRITERIA

Even more progress has been made in the high-end 3-D graphics arena, where tasks once relegated to \$50,000 workstations can now be tackled on a Pentium-class PC equipped with a high-end, 3-D-capable board. Users can now work with 3-D design and engineering packages, build fly-throughs of architectural models, invent virtual worlds and 3-D animations, and create visualization and simulation demos to manipulate complex 3-D geometric shapes. To do these, you need a graphics board that can offload many of the complex calculations from the CPU and aid the graphics pipeline. Without it, any movement in 3-D space will appear choppy and unrealistic.

Our research turned up ten products from eight vendors. The AccelGraphics, Diamond Multimedia, ELSA, Fujitsu, Omnicomp, and Symmetric entries are built around the 300SX processor from 3D Labs; Symetric also employs the new 3D Labs Delta coprocessor chip. Dynamic Pictures and Oki (a division of Okidata) have entries based on their own 3-D processors.

The Pentium and Pentium Pro processors, with their ability to quickly process floating point calculations, can now handle a major requirement of 3-D graphics: calculating the geometry at the beginning of the 3-D pipeline. As you move through Z space, or depth, objects in the background appear smaller than those in the fore-

ground. Matrix math is used to compute the transformation associated with the movement of each triangle from one fixed point in space to another. Shading, lighting effects, and varying levels of transparency give the added effect of realism.

This world of high-end OpenGL 3-D is

2-D graphics acceleration

Matrox Millenium

3-D graphics acceleration

Fujitsu Sapphire 3D Designer Symmetric GLyder 16

Graphics professionals, DTP users, and 2-D CAD designers have several excellent choices from among the seven boards we tested. The best all-around package

is the Matrox Millenium. Sporting 4MB of RAM and Matrox's own MGA chip set, the Millenium delivers ultra-high refresh rates—102 Hz in 1,600-by-1,200 16-bit color mode—for rock-solid displays in your image editing package. It was at or near the top in all of our performance tests, and Matrox has done an excellent job of integrating the card into the Windows 95 environment. Beyond the standard creature comforts (controls for resolution, color depth, virtual window, hardware pan and zoom) the drivers let you select from up to four different configurations via a Quick Access toolbar, so you can quickly toggle among different resolution and color-depth modes with a click of the mouse. The Millenium is affordably priced at \$470 on the street, and Matrox reports that price should drop to around \$400 by the time you read this.

Three of the other 2-D boards rival the Matrox in performance and functionality, and warrant honorable mentions. Our Editors' Choice from last year has aged well: Number Nine's Imagine 128 remains an excellent choice for handling large bitmaps and vector graphics, showing excellent performance in these areas. The brand new Imagine 128 Series 2 Number Nine is a board to watch. It promises to

outperform all others in this group, though the driver set was not fully complete as of our testing. Finally, for those who live and breathe in Windows 95, Hercules has put a good deal of effort into optimizing its Windows 95 implementation of the Terminator Pro. The payoff: easy setup, an excellent feature set, and decent performance.

We saw a fair number of thoroughbreds in the OpenGL 3D arena as well. The best board overall and one of our Editors' Choices is the Symmetric GLyder. It excelled at every 3-D task

we asked it to perform, from CAD to modeling to animation, thanks to its Glint architecture with the new 3D Labs Delta coprocessor. Another Editors' Choice goes to the price/performance leader in the category, the Fujitsu Sapphire 3D Designer. It delivers good performance on a range of tasks at all but the highest resolution modes, all at less than \$1,000 on the street—a bargain in this category.

Dynamic Pictures' V192 merits an honorable mention. At \$4,000 it isn't cheap, but it excels at 3-D CAD tasks that would otherwise require a much more costly workstation. For 2-D CAD as well as 3-D work, the ELSA GLoria (\$2,500 street) deserves an honorable mention as a solid jack of all trades.



far different from the Direct3D acceleration designed primarily for games and mainstream business use. Direct 3D accelerators will trade off OpenGL-style accuracy for performance. But these OpenGL boards must deliver both: life-like realism (for product renderings and

High-End Graphics Boards

medical imaging, for instance) at usable performance speeds. And it comes at a price. While the mainstream Direct3D cards will sell for about \$200, these high-end 3-D capabilities run between \$1,000 and \$4,000.

Whatever your need, be it high resolution and refresh rates in the 2-D realm or workstation-level 3-D, one of the graphics accelerators in the sections that follow will have what it takes.

ATI Technologies Inc.

ATI Graphics Pro Turbo

The ATI Graphics Pro Turbo (\$539 list, \$435 street) boasts high refresh rates, stable Windows 95 drivers, and nicely integrated Windows 95 utilities. Several other products with similar features outperformed the Graphics Pro Turbo by significant margins, and ATI will soon replace the board with a newer design. But if you can scoop up this card at a bargain price, it might be worth the performance tradeoff.

Installing the card under Windows 95 was simple and straightforward. ATI's Help Wizard guides you through the process, and the Plug and Play-compliant card can correctly set refresh rates using either Windows 95 monitor INF files or DDC-1 or DDC-2b. Boasting a top vertical refresh rate of 100 Hz at a resolution of 1,024 by 768 pixels in 16-bit color, the Graphics Pro Turbo sustains a reasonably flicker-free vertical refresh rate (70 Hz) in 16-bit color at its maximum resolution, 1,280-by-1024.

ATI's Windows 95 utilities are integrated via folder tabs into the Display Properties dialog box. Individual tabs let you change refresh rates on the fly, set

ATI GRAPHICS PRO TURBO	
SUITABILITY TO TASK	
Graphics design	Good
Win 95 integration and stability	Good
2-D CAD	Excellent
Mainstream usability	Good

hotkey combinations for pan and zoom functions, or adjust color mappings; resolution (desktop and virtual) and color depth changes are grouped under a slightly altered Settings tab. You cannot change color depths on the fly. ATI's Desktop Help says (erroneously) that Windows 95 does not support such "hot-switching," though we were able to with Diamond Multimedia's Stealth64, whose InControl Tools indeed let you hot-switch.

Based on ATI's aging Mach64 accelerator, the Graphics Pro Turbo performed relatively poorly on our Winbench 96 test suite, achieving barely half the Graphics WinMark 96 score of the fastest board in the review. Its Winstone results were also disappointing: The board tied for last place on the 16-bit version of Winstone 96, and stood alone at the bottom of the pack on the new 32-bit version of Winstone 96. The board had problems completing our automated Photoshop script: Both the Display Time and Overall Run Time results were significantly worse than any of the other products'. The Graphics Pro Turbo held its

own on our DOS AutoCAD and QuarkXPress performance tests, but those were the only performance bright spots.

The board's ability to sustain high refresh rates under demanding conditions, stable driver set and well-designed Windows 95 utilities indicate that, at the right price, the Graphics Pro Turbo provides a viable choice for general-business users and page-layout specialists. Graphic artists and other performance hounds will be better off looking elsewhere, however.—Jon Hill

ATI Graphics Pro Turbo. List price: \$539. ATI Technologies Inc., Thornhill, Ontario, Canada; 905-882-2626; fax, 905-882-2620. Circle 506 on reader service card.

Diamond Multimedia Inc.

Diamond Stealth64 Video 3400XL

Diamond Multimedia Systems has fleshed out its product line and changed its naming system since we last reviewed high-end graphics cards, and this Diamond Stealth64 Video 3400XL (\$569 list, \$484 street) is the same board as the Stealth 64 Video VRAM we awarded an Editors' Choice a year ago. Diamond has added new GT Drivers and InControl Tools for Windows95, and the board remains a solid all-around product.

The S3 968-based Stealth64 combines 4MB of VRAM (2MB on-board and a 2MB daughtercard) and an IBM 9314 Palette DAC to provide a nicely saturated display. Diamond's new InControl Tools for Windows 95 are extremely versatile

2-D GRAPHICS ACCELERATORS

How to Read the Suitability to Task Boxes

Though the sexier 3-D accelerators are grabbing all the limelight, 2-D graphics accelerators bring home the bacon for graphics professionals, DTP users, and the majority of CAD designers. These users demand color calibration, user friendliness, and strong AutoCAD capabilities.

To rate well in **graphics design**, a board had to offer 24-bit true-color support at high resolutions. Color calibration and other creature comforts are also important.

Win 95 integration and stability is an important aspect to consider, since this is the dominant platform users will be working under. To do well here, a board had to

be easy to set up and configure. It should be simple to change the refresh rate, and the card should offer advanced Windows 95 features such as true on-the-fly resolution switching and full integration into the Display Properties dialog box.

To rate an **excellent** in **2-D CAD**, a board must offer robust DOS AutoCAD support. AutoCAD for other operating systems such as Windows 3.1 and Windows NT is a plus. The board had to support high refresh rates at the highest resolutions for rock-solid image quality. It should also be able to support AutoCAD on more than one operating system.

Mainstream usability addresses overall performance on our Winstone and WinBench benchmark tests, as well as special bonus features such as bundled utilities, MPEG drivers, and upgrade paths.

SUITABILITY TO TASK	
Graphics design	Poor
Win95 integration and stability	Fair
2-D CAD	N/A
Mainstream usability	Excellent
N/A—Not applicable. The product does not support this feature.	

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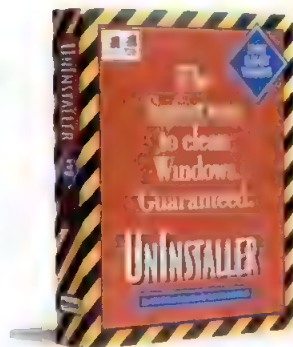
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HEY, EVERYONE CAN USE A LITTLE HELP.

High-End Graphics Boards

and complete; NT users won't get a version until after Microsoft releases Windows NT 4.0 later this year.

Setting up the Stealth64 Video 3400XL under Windows 95 was simple and straightforward. Start Windows 95 using its standard VGA display driver before installing the GT drivers and InControl Tools, and let Diamond's Install wizard walk you through the rest of the process. The DirectX-enabled drivers use Windows 95's monitor INF files to determine appropriate resolutions and refresh rates for your monitor, but you can create custom configurations for new or unsupported monitors.

Once installed, the InControl Tools integrate into Window 95's Display Properties sheet, and are easily accessible via a click of the right mouse button on the Windows 95 background. You can do just about anything with a click or two: change resolutions and color depths on the fly, activate the virtual display, adjust the pan and zoom hot keys, even start an application with a click of the right mouse button. While you can't associate an application with a resolution or color depth, it's not too difficult to swap on the fly and then start the application: two right-mouse clicks will do the trick. Diamond provides an astonishing level of functionality through its InControl Tools; in fact our only complaint was that the right-click menu can quickly fill up to the point of confusion. Fortunately, you can remove infrequently used items from the menu to keep it manageable.



The Stealth64 performed adequately on our suite of performance tests, though other products have closed the performance gap it enjoyed a year ago. WinBench performance, as measured by the Graphics WinMark 96, was squarely in the middle of the pack. Under Winstone 96, the card fared somewhat better, but page-layout specialists will be disappointed by the card's poor performance on our automated QuarkXPress tests. The

Stealth64 did somewhat better on our Adobe Photoshop 3.0 suite, where it finished roughly even with the top-scoring Matrox Millenium under Windows 95. AutoCAD performance under DOS, provided by Panacea's Turbo DLD Deluxe driver, was surprisingly good, but Diamond doesn't supply CAD drivers for Windows NT.

The company bundles a wide array of software extras with the Stealth64, including Asymetrix's 3D F/X, CorelDraw 4.0, and CompCore's SoftPEG software MPEG player. Diamond also offers an MPEG daughtercard (\$299) for video playback.

By the end of the year, the Stealth64 Video 3400XL will be replaced by a 3-D-enhanced version of the card based on S3's Virge/VX accelerator. In the meantime, this solid offering is still a top choice.—JH

Stealth64 Video 3400XL List price: \$569. Diamond Multimedia Systems Inc., San Jose, CA; 800-468-5846, 408-325-7000; fax, 408-325-7070. Circle 507 on reader service card.

ELSA Inc.

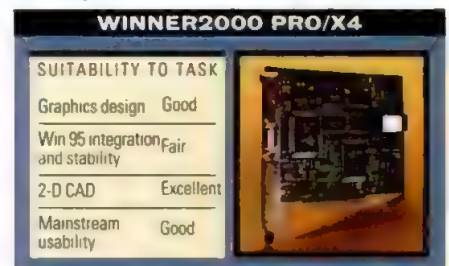
Winner2000 Pro/X4

Like vintage wines, graphics card drivers that cycle through our high end testing have good years and bad years. Unfortunately, this was a bad year for ELSA's Winner2000 Pro/X4 (\$599 list), which performed poorly on our hardware benchmark tests and ships with outdated graphics utilities. Only those with a steady diet of Windows NT-based AutoCAD will find this board palatable: ELSA is the sole supplier of Windows NT AutoCAD drivers.

The Winner2000 Pro/X4 employs S3's Vision 968 graphics chip and Texas Instruments' 220 MHz TFP3026-220 PCE DAC, producing an adequate refresh of 80 Hz in 1,600-by-1,280 16-bit mode, and an outstanding 160 Hz in 800-by-600 24-bit mode. The Winner2000 Pro/X4 doesn't include 32-bit Windows 95 utilities, instead relying upon its Windows 3.1 programs to perform double duty. In addition to AutoCAD drivers for DOS, Windows 3.1, and NT, ELSA provides software MPEG drivers and Leadview's image management and compression software.

Working with ELSA's Windows 3.1 drivers on our Windows 95 test-bed was problematic. Trouble started during installation, which seemed to run normally but failed to copy over the required files or create program icons, which we did manually. Our woes continued when we tried loading the driver that activated ELSA's virtual desktop, which crashed on three different computers, and ultimately never worked on our bench systems.

Once running, ELSA's drivers proved stable, working through our application stress testing without incident. In addition to its basic configuration program, ELSA provides several useful utilities, including RunMan, a toolbar for one click



application loading; ERGONOMeter, which measures refresh rate and scan frequency; and GAMMAMAN for color calibration.

ELSA's software forte remains AutoCAD. All utilities are full-featured and mature, illustrating the depth of ELSA's experience in the CAD market. ELSA's Windows 3.11 drivers benefit from MULTIman, which lets users install up to three ELSA cards, each fully configurable to a unique view. A similar utility enables dual-screen mode in the Windows NT environment. But these creature comforts come at a pretty stiff price. ELSA ranked last or second to last in most hardware performance tests, taking over twice as long to complete the Zoom and Pan tests as our fastest boards. We contacted ELSA to confirm our results, and company officials stated that they were optimizing the drivers for re-release later in 1996.

The Winner2000 Pro/X4 placed a distant sixth of seven on our WinBench tests, proving slightly over half as fast as the speediest entries. Placement was similar on the Winstone tests, though the performance gap between the Winner2000 Pro/X4 and faster boards was much smaller. Windows application performance verified the results, as ELSA

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Dell's featured computer artist is Marco Marinucci of San Francisco, CA.

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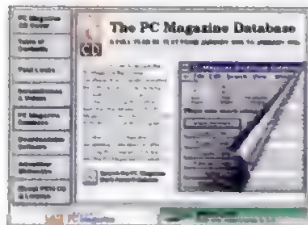
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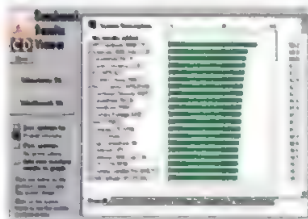
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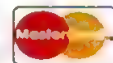
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SUMMARY OF FEATURES

High-End 2-D Graphics Accelerators



■ YES ■ NO	ATI Graphics Pro Turbo	Diamond Stealth64 Video 3400XL	ELSA Winner2000 Pro/X4	Hercules Terminator Professional	Matrox Millennium	Number Nine Imagine 128	Number Nine Imagine 128 Series 2
Products listed in alphabetical order							
List/street price	\$539, \$435	\$569, \$483	\$599, \$500	None, \$499	\$549, \$479	\$699, \$639	\$699, \$699
Graphics accelerator chip	ATI mach64	S3 Vision 968	S3 Vision968	S3 Vision968	MGA 2064W	Imagine 128	Imagine 128 Series 2
Data path	64-bit	64-bit	64-bit	64-bit	64-bit	128-bit	128-bit
Video acceleration/Color space conversion/3-D acceleration	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■ ¹	■ ■ ■	■ ■ ■ ¹
RAMDAC	IBM Palette DAC	TI TVP3026	TI TVP3026	IBM ESD 9314	TI TVP3026	TI TVP3026	IBM Palette DAC
RAMDAC speed	220 MHz	220 MHz	220 MHz	220 MHz	220 MHz	220 MHz	220 MHz
Display Characteristics							
Display memory included	4MB VRAM	4MB VRAM	4MB VRAM	4MB VRAM	4MB WRAM	4MB EDO VRAM	4MB EDO VRAM
Maximum installable memory	4MB	4MB	8MB	4MB	8MB	4MB	4MB
Maximum noninterlaced graphics resolution (dpi)	1,600 x 1,200	1,600 x 1,200	1,600 x 1,280	1,600 x 1,280	1,600 x 1,280	1,600 x 1,280	1,600 x 1,280
Maximum number of colors/Refresh rate at:							
1,600 by 1,280	65,000, 76 Hz	65,000, 76 Hz	65,000, 80 Hz	65,000, 72 Hz	65,000, 85 Hz	65,000, 83 Hz	65,000, 83 Hz
1,280 by 1,024	16.7 m., 60 Hz	16.7 m., 90 Hz	16.7 m., 83 Hz	16.7 m., 75 Hz	16.7 m., 110 Hz	65,000, 118 Hz	65,000, 118 Hz
1,024 by 768	16.7 m., 75 Hz	16.7 m., 120 Hz	16.7 m., 104 Hz	16.7 m., 90 Hz	16.7 m., 120 Hz	16.7 m., 150 Hz	16.7 m., 150 Hz
1,152 by 864	16.7 m., 60 Hz	16.7 m., 90 Hz	16.7 m., 82 Hz	16.7 m., 60 Hz	16.7 m., 120 Hz ²	16.7 m., 150 Hz	16.7 m., 150 Hz
800 by 600 (Super VGA)	16.7 m., 100 Hz	16.7 m., 120 Hz	16.7 m., 160 Hz	16.7 m., 120 Hz	16.7 m., 200 Hz	16.7 m., 150 Hz	16.7 m., 150 Hz
Drivers and Software							
Supports Direct Draw/Direct Video	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Windows 95, Windows NT, OS/2 3.0 drivers available	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
AutoCAD driver	Proprietary	Panacea	ELSA Power	Panacea	Matrox	Panacea	Panacea
Driver directly supports DOS/Windows/Windows NT	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Dual-screen support	■	■	■	■	■	■	■
Pop-up menus/Customizable pop-up menus	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Real-time pan and zoom/Bird's-eye view	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Display list processor/Graphics-mode text	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
On-the-fly resolution adjustment/refresh rate control	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
On-the-fly color depth adjustment	■ (Win 3.1 only)	■	■	■	■	■	■
Virtual Desktop features:							
Maximum size	2,048 x 1,536	2,048 x 1,536	1,600 x 1,200	1,600 x 1,200	1,600 x 1,200	3,200 x 1,200	3,200 x 1,200
Pan and zoom/Auto-centering	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Color calibration of RGB value/DPMS	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Video playback utility/Software MPEG	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Hotkey access to graphics utilities	■	■	■	■	■	■	■
Bundled third-party software	None	3D F/X, Corel-Draw 4.0, Digital Video Producer	None	None	3D F/X, NASCAR racing	SoftMPEG 95	SoftMPEG 95
Customer Support							
Warranty (parts and labor)	5 years	6 years	3 years	5 years	3 years	5 years	5 years
Technical-support hours (eastern time)	9:00-7:00 M-F	8:00-10:00 M-F, 11:00-7:00 Sat.	11:00-9:00 M-F	9:00-9:00 M-F	8:30-6:30 M-F	8:00-8:00 M-F	8:00-8:00 M-F
Web address (http:// _____)	www.atitech.ca	www.diamond .mm.com	www.elsa.com	www.hercules .com	www.matrox.com /mga	www.nine.com	www.nine.com

(1) A 3-D driver set was not available for testing. (2) 1,152-by-882 resolution. m. = million.

placed last or second to last in QuarkXPress and Photoshop tests.

Over the last 12 months, ELSA stood still in a fast-moving market, falling behind in both hardware performance and software utility. CAD users may want to take a look, but others should pass until the company improves its drivers.—*Jan Ozer*
Winner2000 Pro/X4. List price: \$599. ELSA Inc., Sanya Clara, CA; 800-272-3572, 408-565-9669; fax, 408-565-9650. *Circle 508 on reader service card.*

Hercules Computer Technology

Terminator Professional

With above-average benchmark test performance and a competent set of graphics utilities, Hercules' \$449 Terminator Professional is a solid choice for graphics professionals working in Windows 95. The Terminator Professional ships with DOS AutoCAD drivers, but provides only basic graphics support for Windows NT support and none for

Windows 3.1 or NT AutoCAD.

The Terminator is built around S3's Vision 968 graphics chip and IBM's ESD 9314 220-MHz DAC, which combine to provide middle-of-the-road refresh rates in big-screen, high-color modes. For example, the refresh rate in 1,280-by-1,024 24-bit mode was only 75 Hz, and dropped to 72 Hz in 1,600-by-1,200 16-bit mode. While acceptable for occasional tasks, these rates would prove tiring for professionals who live in these resolutions.

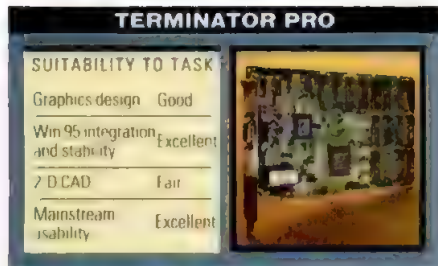
High-End Graphics Boards

The card ships with drivers for Windows 3.1, 95, and NT, as well as Panacea's DOS AutoCAD drivers. The graphics display utilities are for Windows 3.1 and Windows 95 only. Hercules also supplies color calibration software and a Windows 95 Entertainment Center for controlling CD, MIDI and .WAV audio, Video for Windows, and software for MPEG playback.

Installation of the Terminator's standalone graphics control program, Touch 95, was straightforward. Features include a virtual desktop with pan lock and auto-centering, up to 8X zoom, and control over resolution, color depth, and refresh rate, with preview and screen adjustment. You can change refresh rate and resolution (but not color depth) without rebooting Windows 95.

Fast access to Touch 95 is provided via a selectable hot key or a small optional monitor icon on the Windows 95 taskbar. Touch 95 contains several nice surprises, like a refresh rate meter and comprehensive contact screen and help files.

The Terminator also delivers Color



Right, a capable color calibration program that enables gross monitor adjustments for room lighting, system gamma, and color temperature, and precise RGB adjustment and gamma controls. Color Right is compatible with the Chroma Calibrator, a hardware device from Sequel Imaging for more exact calibration.

While the Terminator was generally the fastest 968-based board on our tests, S3's graphics mainstay is showing its age against faster, more highly tuned chip sets. With the exception of low scores on 2-D CAD tests, it performed very well across our benchmark tests, almost tying with Matrox on the Winstone 96 tests. Visually, the card produced crisp 24-bit images in 1,280-by-1,024 resolution despite the relatively low refresh rates.

By focusing on Windows 95 to the exclusion of Windows NT or CAD, Hercules' Windows 95 creature comforts rival the

best in the category. Windows NT professionals and non-DOS AutoCAD users may want to look elsewhere, but Windows 95 users who value a cushy ride over the ultimate in speed may take to the Terminator.—JO

Terminator Professional. List price: \$449. Hercules Computer Technology, Fremont, CA; 800-532-0600, 510-623-6030; fax, 510-623-1112. *Circle 509 on reader service card.*

Matrox Graphics Inc.

Millennium



Readers who follow the high-end graphics market know that Matrox is a consistent category leader, and this year is no exception. Affordably priced at \$470 on the street (\$549 list), the Millennium bests the field in many hardware performance tests, offers exceptional screen refresh rates, and ships with stable, advanced graphics utilities for AutoCAD and all flavors of Windows.

While it's a great buy for desktop publishing and image editing, don't purchase this board for its claimed OpenGL 3D support: On our tests, we found no discernible benefit from the hardware 3-D acceleration. Matrox has dubbed that driver "defective" and says a replacement is in the works. Still, it is the best all-around 2-D board in this roundup and our Editors' Choice in that category—and an even better deal with an anticipated price cut to around \$400 on the street.

The Millennium is based on Matrox's 64-bit MGA-2064W graphics chip set, with video acceleration, 4MB of Windows RAM, and Texas Instruments' 220-MHz DAC. The Millennium produced a rock-solid refresh rate of 102 Hz at 1,600-by-1,200 16-bit color depth—30 percent higher than the slowest boards here.

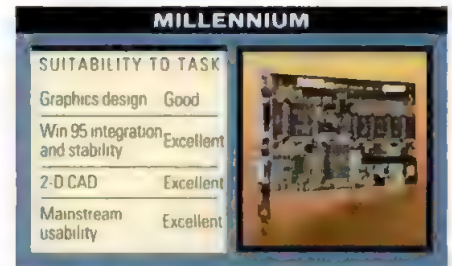
The Millennium ships with an elegant set of CD-ROM-based Windows 95 utilities that are neatly integrated into Windows 95 Display Properties controls. In addition to controls over resolution, color depth, and virtual window, Matrox lets you select four discrete graphic configurations, accessible via a Quick Access toolbar. You can quickly toggle between 640-by-480 8-bit mode for word

processing and 1,280-by-1,024 24-bit mode for image editing—a time-saver if you frequently change graphics configurations.

Our test product arrived with a less complete color management utility, but Matrox plans to include the color management utility by Sonnetech. Overall, our only complaint was that Matrox didn't include help files with its utilities, instead supplying on-line documentation in Wordpad format. This proved cumbersome when searching for quick answers.

The Millennium sailed through real-world evaluation in both Windows 95 and Windows NT without compatibility or stability problems. We did notice some jerkiness during slow panning in virtual screen mode, with the mouse jumping about an inch when touching an edge rather than sliding pixel by pixel. While certain other boards shared this characteristic, the movement from the Millennium was more pronounced.

The Millennium placed second on



WinBench tests and first on Winstone 96 and Winstone 32 tests, which predict performance in 16- and 32-bit applications. Matrox provides comprehensive AutoCAD utilities for Windows 3.1 and DOS, but not for Windows 95 or NT. The Millennium was a strong performer on our DOS AutoCAD tests, and the depth of Matrox's AutoCAD utilities makes the Millennium an excellent choice for AutoCAD users.

In short, the Millennium offers outstanding price/performance characteristics for those interested in image editing and desktop publishing. Unless you're working on AutoCAD on the Windows NT platform, the Millennium should definitely be on your short list.—JO

Millennium. List price: \$549. Matrox Graphics Inc., Dorval, Quebec, Canada; 800-361-1408, 514-969-6320; fax, 514-685-2853. *Circle 510 on reader service card.*



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High-End Graphics Boards

Number Nine Visual Technology

Imagine 128,
Imagine 128 Series 2

Both the Imagine 128 (\$699 list) and its newer sibling, the Imagine 128 Series 2 (\$699 list) combine top-flight performance with exceptional utilities and productivity tools. An Editors' Choice in last year's high-end review, the Imagine 128 has aged well, and remains an excellent choice for handling large bitmaps and vector graphics. The Series 2 boasts a souped-up 2-D graphics engine, and as-yet untapped features that promise to deliver enhanced video and 3-D capabilities as well.

Both cards feature Number Nine's Hawkeye95 display control utilities, a user-oriented suite that is among the best designed in the business. Accessible via the Display Properties dialogue or directly from the Windows 95 taskbar, Hawkeye95's individual components work to-

IMAGINE 128	
SUITABILITY TO TASK	
Graphics design	Excellent
Win95 integration and stability	Excellent
2-D CAD	Excellent
Mainstream usability	Excellent

gether to form an integrated set of tools.

Valuable features include an excellent Status page that lists everything from the current resolution and driver version to the bus size and BIOS revision. A simple but effective Monitor Adjustment utility lets you safely adjust the refresh rate and create custom configurations, and a well-designed color calibration utility called Color Perfect includes individual linear adjustments in RGB or CMY color space.

The Imagine 128 and Imagine 128 Series 2 run neck and neck at the top end of the 2-D accelerator market. Each delivers super fast refresh rates, topping out at an astounding 83 Hz in 1,600-by-1,200 16-bit color mode—if you can afford a monitor to handle that combination.

While we were unable to test the Series 2's performance in several areas—the card's MPEG and CAD software arrived after we had completed testing, and its OpenGL drivers for Windows NT remain unavailable as of this writing—a look at the card's WinBench 96 scores provides some insight

into the chip's raw capability. At a resolution of 1,024-by-768 in true color mode, the card achieved an excellent Graphics Winmark score of 26.5. To put this in perspective, consider that most current midrange products process roughly the same number of pixels in 256-color mode as the Series 2 processes in true-color mode.

Under Windows 95, the early Series 2

IMAGINE 128 SERIES 2	
SUITABILITY TO TASK	
Graphics design	Excellent
Win 95 integration and stability	Excellent
2-D CAD	N/A
Mainstream usability	Excellent

drivers we tested did not completely deliver on the new chip's promise, but were solid and complete and include advanced DirectDraw support. The card is expected to scale nicely as Pentium Pro processors and 64-bit PCI buses enter the market, thanks in part to its Intelligent Command Processor and support for PCI bursts.

The older Imagine 128, no performance slouch itself, was the fastest Photoshop and QuarkXPress engine, finishing just ahead of the Series 2.

If you want rock-solid images and the best tools in the business, consider either Imagine card. As Number Nine improves the breadth and depth of the Series 2 drivers, this promises to be the card to watch.—JH

Imagine 128. List price: \$699. **Imagine 128 Series 2.** List price: \$699. Number Nine Visual Technology, Lexington, MA; 800-438-6463, 617-674-0009; fax, 617-674-2919. Circle 511 on reader service card.

OPENGL 3-D ACCELERATOR CARDS

AccelGraphics Inc.

AccelR8

ALL REVIEWS BY LINDA AND ERICK VON SCHWEBER

AccelGraphics, formed after the dissolution of Kubota Denali Graphics, is known for high-performance 3-D engines. The AccelR8 (\$1,295 list) is the company's first attempt at a scaled-down, entry-level product for the price-conscious purchaser. The AccelR8's performance was average, but the relatively low price means some tradeoffs in

functionality.

The AccelR8 does not have an on-board VGA chip, so you must use the included external pass-through cable. We reviewed an early version of the AccelR8 and experienced a driver problem on installation, which AccelGraphics quickly corrected. The manual provided is sparse but accurate. The AccelR8 comes with a 16-bit z-buffer. This posed no compatibility problems for any of the software we used in testing, and the card can be easily expanded to a full 24-bit z-buffer by the user with an optional daughtercard.

In testing, we were limited to 800-by-600 15-bit color mode, as the AccelR8 lacks support for double-buffered high color and true-color modes in both 640-by-480 and 1,024-by-768. Since it lacks texture assist and support for a 640-by-480 high-color mode, we could not use it for VR, VRML, or simulations—applications which seek to maximize performance by keeping to low resolution and 15-bit color.

In 800-by-600 15-bit mode, however, the AccelR8 fared well for an entry-level product in our simulation test and in handling transparency, outshining the similarly priced Fujitsu Sapphire 3D Designer in these areas. Only in the texture test did

ACCEL R8	
SUITABILITY TO TASK	
Visualization	Fair
3-D Cad/CAE	Fair
Virtual reality	N/A
3-D animation	Fair
2-D CAD	Good

the AccelR8 fall to an unacceptable level of performance.

AutoCAD results place it mid-field, and AccelGraphics offers a driver add-on called AccelView (\$399) that makes working with 3-D objects easier. This utility, which can be used with any AutoCAD driver, lets you grab and spin an object with the mouse, rather than having to enter rotational coordinates in degrees.

Without a high-color, double-buffered high-resolution mode we could not recommend the AccelR8 for the 3-D animator or high-end CAD user. But if your visualization work does not require texture support, or if your design work can be performed with 8-bit color, then the AccelR8 may work for you.

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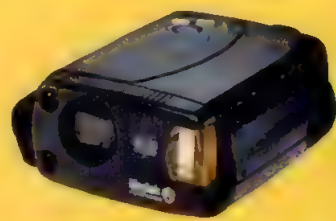
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Diamond Multimedia Inc.

Diamond FireGL

The Diamond FireGL is an accelerator card in transition, getting both a new processor and a new owner. The \$1,995 3-D accelerator is designed and manufactured by SPEA of Germany, a long-time maker of high-end cards. The FireGL represents a move onto a new accelerator chip, the Glint 300SX from 3D Labs. Diamond Multimedia recently acquired SPEA, and has repackaged the FireGL for U.S. customers.

Unfortunately, problems with the FireGL began early in our experience. We first tried to install the repackaged FireGL card. The installation instructions were seriously at odds with the supplied floppy disks and CD, making installation impossible. So instead we installed and tested the German version, packaged by SPEA. We later received a new package from Diamond. Though the installation instructions were improved, the drivers would not install, spawning Windows error messages. Like its German twin, the finished U.S. version will deliver support for Direct3D and Windows 95, and an enhanced 3-D viewer for Auto-

CAD in Windows.

The FireGL supported all the resolutions and color depths our testing required, up to 24-bit at 1,024-by-768, but overall it was at the bottom of the performance heap. Only on the texture test did the FireGL earn special 3-D attention, where it posted the second-best score of the cards we tested. In AutoCAD testing the FireGL preferred the WHIP driver, generally returning average scores except for regenerates, where it placed second, just behind the ELSA GLoria 8.

The unit's test results make it tough to recommend the present iteration of the FireGL for visualization and 3-D animation tasks. With the proven Glint engine and SPEA's track record, the board could

DIAMOND FIREGL	
SUITABILITY TO TASK	
Visualization	Poor
3-D Cad/CAE	Poor
Virtual reality	Fair
3-D animation	Poor
2-D CAD	Good

mature into a viable choice, once Diamond works out the rough edges.

Diamond FireGL. List price: \$1,995. Diamond Multimedia Inc., San Jose, CA; 800-468-5846, 408-325-7000; fax, 408-325-7070; <http://www.diamondmm.com>. Circle 514 on reader service card.

Dynamic Pictures

V192 Graphics Accelerator Module

The V192 Graphics Accelerator Module is an ideal high-end 3-D CAD board, able to maintain respectable real-time performance right up to 1,280-by-1,024 resolution at 24-bit true color. With a list price tag of \$4,000, the V192 isn't for everyone. But it enables you to perform complex CAD/CAE chores on a PC that would otherwise require a more expensive workstation.

Installation was simple and direct, and since the V192 features an onboard 2-D chip you'll need no pass-through cable. In testing we noticed no visible performance hit in 2-D GUI operations as we moved up to higher resolutions. The documentation provided is accurate but sparse. Drivers are included for Windows NT for Alpha AXP, Intel, and MIPS platforms. Installation follows the Windows NT norm, using the Display icon of the control panel.

Most of the boards we reviewed can claim acceptable performance at low resolutions and shallow color depths, but the V192 delivers performance across the spectrum. In changing resolutions from our minimum 640-by-480 display to a full 1,280 by 1,024 pixels, the frame rate of the Dynamic Pictures V192 dropped

3-D GRAPHICS ACCELERATORS

How to Read the Suitability to Task Boxes

The high-end OpenGL accelerators we reviewed can be used for a range of tasks, the most popular of which we evaluate here. To rate the boards, we analyzed test results at color depths and resolution appropriate for each task, checked image quality, and looked at the array of specific features offered. Quick frame rates and accurate effects are the hallmarks of a winner.

Visualization tasks aim to answer questions such as "What does data mean?" or "Will flap A fit into slot B?" This requires high resolution, accurate color, and real-time performance. To earn a rating of *excellent*, a board had to deliver 1,024-by-768 and 1,280-by-1,024 resolutions in 15- and 24-bit color depths, handle simple and complex models, and support transparency.

For **3-D CAD/CAE**, users employ full 3-D, with smooth-shaded views in high resolution. Better accelerators deliver 1,024-by-768 and 1,280-by-1,024 resolutions across both simple and complex models as well as offering real-time walk-

throughs. The board should also be compatible with Microstation, Pro/Engineer, and Pro/JR., the CAD programs of this genre.

Virtual reality, including VRML and simulations, demands the highest frame rates for a lifelike feel. These applications use optimized models (reduced number of polygons) and simple texture maps to add detail and richness. To earn an *excellent*, an accelerator needed to yield very high frame rates at 640-by-480 resolution.

Professional **3-D animation** and modeling works at high resolution and the highest color depths, employs transparency and textures, and requires substantial acceleration for real-time previews. For this task we looked for usable performance at high color in 800-by-600 and 1,024-by-768 and true color at 1,024-by-768 and 1,280-by-1,024, all double buffered.

Many of the boards tested can serve double duty as accelerators for **2-D CAD** programs. We looked for uniform results across pans, zooms, erase, regenerates, and 3-D twist, in 1,024-by-768 8-bit color mode.

SUITABILITY TO TASK	
Visualization	Poor
3-D Cad/CAE	Fair
Virtual reality	Good
3-D animation	Excellent
2-D CAD	Excellent

12.1" SVGA Active Matrix or
11.3" SVGA Dual Scan Color Display

Video/TV
Presentation Port

Programmable
Windows 95® Keys

Signature™ Adjustable
Ergonomic
Keyboard

Touch Sensitive
SensPad™
Pointing Device

Internal 4x or 6x
CD-ROM Drive

1MB of
Video RAM

SoundBlaster 16
with Built-In Mic
and Stereo Speakers

Infrared
Data Transfer

Up to 2.1 GB
Removable
Hard Disk Drive

Two Type II or
One Type III PC Card
Expansion Slots

Up to 10-Hour
Life with optional second
Lithium Ion Battery

Available with
100, 120 or 133 MHz
Pentium® processor

The new **SENS™ 810**. The keyboard is just one of the features you'll love to get your hands on.

SENS™ 810

PENTIUM® PROCESSOR	100 MHZ	100 MHZ	120 MHZ	133 MHZ
RAM	8 MB	8 MB	16 MB	16 MB
HDD	810 MB	1.3 GB	1.3 GB	2.1 GB
DISPLAY	11.3" SVGA Dual Scan Color	12.1" SVGA Active Matrix Color	12.1" SVGA Active Matrix Color	12.1" SVGA Active Matrix Color
CD-ROM	4x CD-ROM	6x CD-ROM	6x CD-ROM	6x CD-ROM
BATTERY	Lithium Ion	Lithium Ion	Lithium Ion	Lithium Ion
MODEM	—	—	—	28.8 Kbps Fax Modem
WARRANTY	3 year	3 year	3 year	3 year
PRICE	\$2,999	\$3,799	\$4,299	\$4,999
BUSINESS LEASE	\$120 per month	\$140 per month	\$159 per month	\$184 per month

FREE Mini-Dock Docking Station with purchase of SENS™ 810 while supplies last.

SENS™ 800 (not pictured)

PENTIUM® PROCESSOR	75 MHZ	75 MHZ	90 MHZ
RAM	8 MB	8 MB	8 MB
HDD	520 MB	810 MB	1.3 GB
DISPLAY	10.4" SVGA Dual Scan Color	10.4" Active Matrix Color	10.4" Active Matrix Color
WARRANTY	3 year	3 year	3 year
PRICE	\$1,799	\$2,199	\$2,699
BUSINESS LEASE	\$72 per month	\$88 per month	\$108 per month

Full 3 Year Warranty and 1-Year Executive Support Program. 24-hour turnaround on repairs. Call for details. 30-Day Money Back Guarantee. Lifetime toll-free 24-hour technical support.

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CIRCLE 033 ON READER SERVICE CARD

BENCHMARK TESTS

High-End Graphics Boards



With most of the older 2-D Windows accelerator boards beginning to show their age, one thing is clear: Driver optimization for improved performance under Windows 95 is still at the top of each developer's to-do list.

What the Numbers Mean

Even after all testing was completed, each vendor asked for additional testing with its latest, newest improved driver. This was such an issue that we allowed vendors to submit a second round of drivers on March 29, just before the end of our testing cycle.

The PC has entered the workstation world. A Pentium Pro PC, coupled with an appropriate 3-D accelerator and OpenGL application, is impressive at many 3-D tasks, including CAD, visualization, animation, and virtual reality.

2-D Test Analysis Our QuarkXPress and Adobe Photoshop tests tell the story of 24-bit graphics performance. Products optimized for vector graphics processing turned in the best results in QuarkXPress. We broke out the captured results for file open time, time spent performing the multiple zoom operations, and vertical scroll operations. The Number Nine Imagine 128 board proved to have the best performance overall in QuarkXPress applications. It's interesting to note the performance differences among the Diamond, ELSA, and Hercules boards, which are based on the same S3 968 controller. Since hardware processing power is essentially the same, depending on the speed the vendor drives the controller's memory clock and RAMDAC's dot clock,

driver optimizations are what seemed to give the Hercules Terminator Pro its edge.

Photoshop tests showed a mixed bag of results. Our Photoshop chart presents both Display Time and Overall Time. The Display Time denotes the total time Photoshop spent waiting for the graphics board to draw the screen. The Overall Time represents the total time it took to run the complete test. In some cases the fastest Display Time performer was not the fastest Overall Time performer. For example, the Matrox Millennium achieved the best Display Time, probably because of its use of WRAM, which has added dexterity in accelerating 24-bit-color bit block transfers, but the Number Nine Imagine 128 achieved the best Overall Time. The ATI Graphics Pro Turbo had difficulty running our Photoshop tests—which were compiled in Visual Test 4.0—and therefore receives an N/A.

The ZD Graphics WinMark 96 and Winstone 96 tests are measures of mainstream performance. They are not designed to perform operations that are native to 24-bit graphics applications. The New Number Nine Imagine 128 Series 2 was the fastest Graphics WinMark performer, proving the strength of the new controller over its older sibling, the Imagine 128, but this also points out the need for more 24-bit driver optimization, since this strength didn't translate as obviously to our QuarkXPress and Photoshop trials. The Millennium proved to be the top performer on our

Adobe Photoshop Display Time	
Seconds	
ATI Graphics Pro Turbo	N/A*
Diamond Stealth64 Video 3400GL	10.2
ELSA Winner2000Pro/X2	13.0
Hercules Terminator Pro	11.2
Matrox Millennium	9.8
Number Nine Imagine128	12.4
Number Nine Imagine128 S. 2	12.1

N/A*—Not applicable: Our automated test could not produce an accurate result. N/A**—Not applicable: There were no AutoCAD drivers available.

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3-D CAPABILITY (1,024-by-768)

Rotate Simple Object

15/16-bit color

24-bit color

Rotate Complex Object

15/16-bit color

24-bit color

Rotate Textured Object

15/16-bit color

Frames per second

	15/16-bit color	24-bit color	15/16-bit color	24-bit color	15/16-bit color
AccelGraphics AccelR8	N/A*	N/A*	N/A*	N/A*	N/A*
Diamond Fire GL	5.8	5.2	3.5	3.1	1.5
Dynamic Pictures V192	N/A**	13.2	N/A**	8.3	N/A**
ELSA Gloria 8	10.1	9.6	7.6	7.4	1.8
Fujitsu Sapphire 28X	9.8	1.5	7.1	1.4	1.6
Fujitsu Sapphire 3D Designer	N/A*	N/A*	N/A*	N/A*	N/A*
Oki TrianGL 10P	9.3	N/A*	3.9	N/A*	0.3
Oki TrianGL 24P	10	10.5	4.1	3.7	0.3
Omnicomp 3Demon	8.9	6.9	8.8	5.4	1.5
Symmetric GLyder 16	10.2	8.0	10.5	8.1	1.5
Intergraph TDZ 300 Workstation ¹	N/A**	17.3	N/A**	18.1	N/A**

BETTER ▶

BETTER ▶

BETTER ▶

BETTER ▶

BETTER ▶

(1) Reported for comparison.

N/A*—Not applicable: The product could not complete this test. N/A**—Not applicable: This product supports only 24-bit color depth.

Winstone tests. It excelled on the new Winstone 32 test, and performed slightly better than the Terminator Pro under Winstone 96.

The AutoCAD for DOS performance chart shows the Panacea-equipped drivers as the faster performers. Except for the Hercules card, which turned in the slowest results, other boards running these drivers performed similarly. The differences of a few seconds either way can be attributed to raw hardware speed.

In many cases products performed within narrow margins of each another across many tests. Driver optimization techniques can easily account for one or two performance points, which can immediately change the ranking order from first to third place. That's why *PC Magazine* views performance as only part of the total picture. A new optimization scheme has emerged for Windows 95, bypassing the operating system's Graphics Device Interface (GDI) and patching common calls for faster processing by the graphics hardware. Matrox and Number Nine have told us they use this technique. Other vendors, like Diamond, state they don't use it because of certain compatibility issues. Part of the controversy over this technique is that it may cause instability under certain applications. Although we have not seen any problems in this round of testing, we will continue to monitor the situation. At the time of this writing, we are awaiting Microsoft's position on this issue.

3-D Test Analysis Take a Pentium Pro PC and equip it with a fast 3-D accelerator board, such as the Symmetric GLyder 16 or the Dynamic Pictures V192, and you'll experience performance and functionality that two or three years ago could be found only on a 3-D Unix workstation. We were able to rotate, translate, fly through, and interact with smooth shaded 3-D models in real time. Lighting and transparency could be freely used. The same cannot be said for texture mapping. Texture "assist," supported on most of the Glint-based boards we examined, is limited in both performance and usefulness. Look for more robust texture handling to make the transition from laboratory to marketplace in the near future.

We found each accelerator to have its own strengths and weaknesses. The performance figures on our 3-D Capability tests characterize each board across tests relevant to visualization, 3-D CAD and engineering, and 3-D animation. The GLyder swept these tests overall, in large part thanks to its Delta geometry preprocessor from 3D Labs, a distinction it will not maintain once other vendors begin shipping their Delta-assisted cards based on 3D Labs' Glint chip. Should your needs fall squarely in the 3-D CAD/CAE realm, then the Dynamic Pictures V192 is the choice solution; its performance is right up there with entry-level workstations.

VR and Simulation present different requirements and demand

continues

	AutoCAD for DOS	QuarkXPress	ZD Graphics WinMark 96	ZD Winstone 96	ZD Winstone 32
Overall Time	Seconds	Seconds	Megapixels per second	Score	Score
178.3	49.5	74.0	14.5	63.0	88.0
147.9	48.4	81.3	20.5	65.4	91.5
152.7	70.9	81.7	14.9	62.7	89.7
144.5	77.9	73.3	21.7	68.7	91.9
141.5	50.6	71.0	25.0	69.6	94.4
136.3	46.4	68.7	22.9	62.7	88.8
143.4	N/A**	70.7	26.5	66.2	92.4
	◀BETTER	◀BETTER	BETTER▶	BETTER▶	BETTER▶

	Rotate Transparent Object		Architectural Fly-Through		Rotate Simple Object (800 x 600)
24-bit color	15/16-bit color	24-bit color	15/16-bit color	24-bit color	15/16-bit color
N/A*	N/A*	N/A*	N/A*	N/A*	8.8
1.4	3.8	2.5	3.2	0.8	5.1
0.2	N/A**	4.2	N/A**	8.7	N/A**
1.8	7.8	7.3	4.8	4.7	16.3
0.9	9	0.1	4.4	4.4	9.4
N/A*	N/A*	N/A*	N/A*	N/A*	12.4
N/A*	N/A*	N/A*	4.9	N/A*	10.7
0.3	N/A*	N/A*	5.4	5.3	11.3
1.5	8.3	6.5	4.2	3.8	12.1
1.4	9.5	6.8	4.9	4.3	14.2
4.8	N/A**	13.6	N/A**	6.0	N/A**
BETTER▶	BETTER▶	BETTER▶	BETTER▶	BETTER▶	BETTER▶

BENCHMARK TESTS

continued

utmost real-time performance. The Virtual Reality/VRML test focuses on factors required for these applications at the combination of resolution and color depth that optimizes performance and is compatible with VR peripherals. Both the GLyder and the Fujitsu Sapphire 2SX proved themselves here with the right feature support and performance that crossed the subjective threshold of 10 fps, where motion begins to appear fluid to the human visual system.

The performance of an accelerator card degrades as you ask it to render more information. Our Rotate Simple Object test portrays each accelerator across a variety of resolutions and color depths. A board like the Sapphire 2SX, exhibiting a wide performance spread, degraded sharply, whereas the Dynamic Pictures V192, exhibiting a narrow performance spread, degraded gracefully.

Until now, PC and 3-D workstations were far afield, differing in price, performance, and supported applications. This has changed. The OpenGL 3D accelerators we reviewed significantly improve the PC's 3-D performance without costing a fortune. On informal tests (not charted), our Editors' Choice—the Symmetric GLyder 16—demonstrated an overall improvement of 400 percent on 3-D operations compared with an unaccelerated 200-MHz Pentium Pro. The only deviation from this was for transparency, where the improvement was 2,000 percent, and textures, where it was 200 percent. This brings the PC's 3-D performance in line with entry-level 3-D workstations. This very significant performance can drive a range of professional 3-D applications now on Windows NT, including AVS/Express, Open Inventor, Sense8 World Up!, Parametric ProEngineer, and Microsoft SoftImage 3D, all functionally identical to their Unix cousins. The chasm has been bridged; the two worlds are one.

In informal testing, on a 100-MHz Pentium-powered Vectra XU we found the Symmetric GLyder 16 and the Dynamic Pictures V192 valuable, delivering about half the performance we saw when these boards were installed in our 200-MHz Pentium Pro test-bed. This means you can gain entry to the 3-D world by simply adding a 3-D card to your current Pentium PC and choosing portable, cross-platform software running on OpenGL.

Need still more power? Just move your OpenGL application to a higher-performance system. Today, 3-D performance gets cheaper the more you buy, no longer doubling cost for a 10 percent improvement. The Intergraph TDZ 300, which we tested for comparison, is an entry-level 3-D workstation that represents the

next step up from 3-D accelerator cards in a Pentium Pro computer. The SGI Indigo2 High Impact exhibited the highest 3-D performance and the best price/performance ratio as well.

How We Tested

We tested the 2-D products on Micron Millennium 133-MHz Pentiums configured with 32MB EDO RAM and 256-Kb L2 cache. Each system was equipped with an Adaptec AHA-2940 PCI SCSI controller card using EZ-SCSI 4.0 software and drivers, Proteon 1392plus Token-Ring network interface card, Conner CFP 2107S (2.1GB) SCSI hard disk, a Plextor PX-63CS 6Plex CD-ROM drive, and the MAG Innovision MXP17F 17-inch monitor.

Our OpenGL 3D test-bed was the HP Vectra XU 6/150 updated with the 200-MHz Pentium Pro chip. Each system had 64MB of memory and a 2.1GB SCSI 2 disk. Graphics display was provided by the Matrox 2MB Millennium card, used as a pass-through device for those boards that lacked on-board VGA. Each system ran Windows NT 3.51 with Service Pack 3, along with Visual C++ 4.0. We used the same MAG Innovision monitors as in the 2-D test-bed.

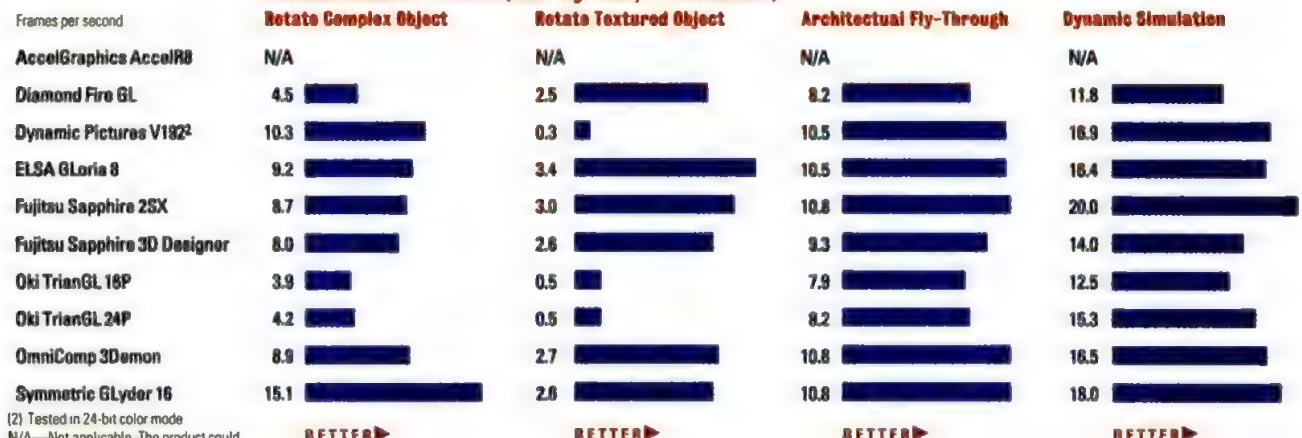
Our OpenGL 3D benchmark tests were application-oriented: Popular OpenGL applications were utilized with performance meters tracking frames per second (fps) on a variety of 3-D models. Each test was conducted in high color at resolutions of 640-by-480, 800-by-600, and 1,024-by-768, and in true color at 1,024-by-768.

We also tested our performance leaders in an entry-level machine, an HP Vectra XU 5/100 powered by a 100-MHz Pentium. We found that these boards, the Symmetric GLyder 16 and the Dynamic Pictures V192, will provide good results in the Pentium you have now. Moving them into a Pentium Pro later will cause their performance to scale up accordingly: We saw performance just about double. This means that you can gain entry to the 3-D world by simply adding a card to your current PC and choosing portable cross-platform software running on OpenGL.

The refresh rate was 75 Hz and all modes tested required double buffering for smooth screen writes. We used AVS/Express, a high-end cross-platform data-visualization tool that allows users to interconnect prebuilt modules to construct sophisticated simulations. For our Simple Object test, AVS/Express was used in conjunction with the industry-standard teapot model consisting of 3,416 triangles, which we looked at smooth-shaded at 0 percent and 50 percent transparency. We also used the more complex

continues

VIRTUAL REALITY/VRML (640-by-480, 16-bit color)



(2) Tested in 24-bit color mode
N/A—Not applicable. The product could not complete this test.

BENCHMARK TESTS

continued

Crambin molecular model, made of 400 interconnected spherical atoms for our Complex Object test.

Next up were two ports of Silicon Graphics. Open Inventor, the high level 3-D SDK that builds on OpenGL and is the parent of VRML (Virtual Reality Modeling Language). Open Inventor is used to build interactive 3-D applications. It defines a 3-D metafile format, .iv, which is portable across platforms and contains the Inventor Scene Graph.

Portable Graphics, an Austin, Texas-based subsidiary of high-end image-generator manufacturer Evans and Sutherland, supplied its Windows NT port of Open Inventor in a late beta

version. With its scene viewer we performed our Architectural Fly-Through test along a preset flight path through an SGI-supplied architectural model called Barcelona, consisting of 5,338 triangles, and we recorded minimum and maximum frame rates. For our Texture test, we loaded a 2,400-

triangle model of 12 spheres, mapped with identical texture maps of the Earth and animated by Inventor Engines to spin at a fixed rate. The frame rate was recorded. For our Dynamic Simulation test we loaded an Open Inventor port from Template Graphics Software, and ran the SGI Slotcar demo. We ran it with a single car and calculated a representative frame rate for each product.

We used our new AutoCAD benchmark test to examine 2-D CAD performance in 1,024-by-768 8-bit-color mode. This test runs a series of AutoCAD operations and records the results. We tested under AutoCAD r13c4 under DOS and Windows NT 3.5.1, and we used either a Rasterex or Whip driver to achieve maximum scoring.

We looked at Intergraph's entry-level workstation, the TDZ300, with its GLZ1T accelerator, which offers texture mapping in hardware and dedicated texture memory. This platform utilizes the same 200-MHz Pentium Pro as our test-bed but includes 128MB of memory. Silicon Graphics facilitated our comparison tests by providing a complete Indigo2 system and system engineer. We used the High Impact, a 250-MHz MIPS R4400-powered machine.

Our new Adobe Photoshop and QuarkXPress tests were developed in Microsoft Visual Test 4.0. Adobe Systems assisted in the development of portions of the Photoshop tests. The Photoshop tests open several graphics files, and performs several operations, including rotate, Gaussian blur, distort filter effect, zoom, and channel operations. We record the display time and total time to run the tests. The QuarkXPress test measures the time it takes to open a 14MB page layout file that contains text, bitmaps, and vector graphics images. The time for each set of operations is recorded.

For a complete description of our new Winstone 32 test program, see the "How We Tested" section of the PC story in this issue.—
Analysis written by Jeff Mace and Erick and Linda Von Schweber

Minutes:seconds		2-D AutoCAD (1,024-by-768, 8-bit color)	
AccelGraphics AccelR8	2:50		
ELSA GLoria 3D ³	1:49		
Diamond FireGL ²	3:00		
Dynamic Pictures V192	N/A		
Fujitsu Sapphire 28X	2:48		
Fujitsu Sapphire 3D Designer	2:42		
OKI Triang 16P	N/A		
OKI Triang 24P	2:22		
Omniscop 3Damon	2:57		
Symantec GLyder 16	2:55		

(3) Tested with vendor-supplied driver.
N/A—Not applicable. The product does not support 1,024-by-768 resolution.

◀BETTER

less than 50 percent on our CAD task; impressive, considering that this resolution shift required over four times as much information to be processed and displayed. By comparison, the overall performance leader in this group, the Symmetric GLyder 16, took a performance hit of 80 percent on the Architec-

asked to perform texture mapping, an OpenGL function it must execute in software only without the benefit of hardware acceleration.

Since engineering and design, such as mechanical CAD and solid modeling, require real time rendering at high resolutions but do not utilize transparency and textures, these shortcomings shouldn't effect the V192's target audience. But VRML and virtual reality developers will need to look elsewhere, at least for the time being. Symmetric reports that future versions of the V192 will accelerate texture mapping.

Dynamic Pictures has plans to introduce lower cost accelerators with greater functionality than the V192 in the future. For now, users of 3-D CAD programs have a simple choice: the V192 or a very expensive workstation.

V192 Graphics Accelerator Module. List Price: \$4,000. Dynamic Pictures Inc., Santa Clara, CA; 408-327-9000; <http://www.dypic.com>. Circle 515 on reader service card.

V192 GRAPHICS ACCELERATOR MODULE	
SUITABILITY TO TASK	
Visualization	Good
3-D Cad/CAE	Excellent
Virtual reality	N/A
3-D animation	Good
2-D CAD	N/A



tural Fly-Through test after we upped the resolution.

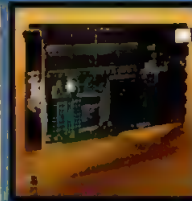
Unfortunately this significant achievement comes at a price. While the Glyder 16 exhibits good performance across all test categories, the V192 suffers when asked to support alpha blending for transparency, and falls on its face when

ELSA Inc.

GLoria 8

The ELSA GLoria 8 is an excellent all-around performer among Glint-based boards, suitable for every task we examined and a standout for 2-D AutoCAD work in particular. With a list price of \$2,849 (\$2,499 street), it's even

GLORIA 8	
SUITABILITY TO TASK	
Visualization	Poor
3-D Cad/CAE	Fair
Virtual reality	Good
3-D animation	Excellent
2-D CAD	Excellent



competitive with the Symmetric GLyder 16, the champion on our tests, when the GLyder's unique Delta geometry coprocessor is disabled. Look for a very promising entry when ELSA releases its Delta-assisted GLoria in late June.

Among the GLoria's special features are support for digital video acceleration

The Tools We Used: A Peek into the 3-D Domain

When Microsoft bundled OpenGL 3D into Windows NT, it opened a crack into the world of professional 3-D rendering. This crack is now a clear passage, thanks to video cards that accelerate OpenGL 3D functions to levels previously seen only on 3-D workstations. Our tests used OpenGL applications from the Unix world, now on NT.

AVS/Express, an impressive visualization tool, was

used to examine two smooth shaded models: the famous teapot and a complex molecule. Next we turned to Open Inventor, an object-oriented 3-D toolkit developed by Silicon Graphics. Using Portable Graphics' port for NT, we conducted a fly-through of Barcelona, an archi-



Figure 1



Figure 2

and provision for very high refresh rates—up to 200 Hz at 1,024-by-768. Several convenient Windows applets are included with the GLoria arc. Installation followed the steps printed in the comprehensive manual, enabling us to get the GLoria up and running quickly.

ELSA has an absolute performance leader in the GLoria 8 for AutoCAD. With the included Heidi-based driver, the GLoria performs regenerates, pans, and zooms in AutoCAD about 3 percent faster than its closest competitor and 50 percent faster than most of the boards in this section.

On the rest of our 3-D test suite the GLoria was consistently strong. It excelled on our rotate textured object tests, beating all other reviewed boards, thanks to its superior use of the Glint chip's texture-assist feature. This makes it well suited to 3-D modeling and animation tasks.

The primary limitation of the GLoria for 3-D work is at very high resolutions and color depths: You can have 1,280-by-1,024 resolution or you can have 24-bit color, but don't ask for both at the same time, as the GLoria struggles when applying this combination. For instance, on our rotate simple object test at 24-bit color the GLoria deliv-

ered 9.6 fps at 1,024-by-768 but only 0.9 fps when we jumped to the higher resolution.

For now, the ELSA GLoria 8 is a good 3-D accelerator and a great AutoCAD board. If ELSA succeeds in maintaining the GLoria's strengths when it adds the Delta geometry chip, it will have another winner.

GLoria 8. List price: \$2,849. ELSA Inc., Santa Clara, CA.; 800-272-3572, 408-935-0350; <http://www.elsa.com>. *Circle 516 on reader service card.*

Fujitsu Microelectronics Inc.

Sapphire 2SX, Sapphire 3D Designer



Both Fujitsu Sapphire boards deliver the performance and features that make them fine choices for a range of 3-D work. The higher-end Glint-based Sapphire 2SX (\$1,989 list, \$1,595 street) is a good all-around performer that stands out for use in virtual reality and simulation. The scaled-down Sapphire 3D Designer (\$1,295 list, \$995 street) is a price/performance standout and earns an

Editors' Choice. It delivers strong performance on tasks from VRML to visualization and even CAD at all but the highest resolutions.

The Sapphire 2SX offers a number of convenient features. For instance, as the 2SX runs it posts records to the Win NT event log should it encounter a system configuration that compromises performance. These reports can help in tuning the 2SX for optimal speed. The board's color-space double buffering, available at

SAPPHIRE 2SX	
SUITABILITY TO TASK	
Visualization	Good
3-D Cad/CAE	Good
Virtual reality	Good
3-D animation	Excellent
2-D CAD	Excellent

a color depth of 12 bits (4,096 colors), increases animation performance without the massive dithering that accompanies 8-bit color and offers a 10 percent performance improvement in frame rate. The 2SX's proprietary Pixel Bus architecture allows up to three Sapphires to be installed in one machine and joined together

HARDWARE

High-End Graphics Boards

tectural model from SGI. Then we checked out texture handling with a simple scene of 12 rotating planets. Using an interactive 3-D application built with Template Graphics Software's Open Inventor port for NT we took a simulated race car for a spin around a simulated track.

—LVS and EVS

The screenshots we present here show some of the worlds that are opening to the PC workstation user.

Figure 1 Test: Rotate Simple Object. Software: AVS/Express. Model: Teapot, 3,416 triangles.

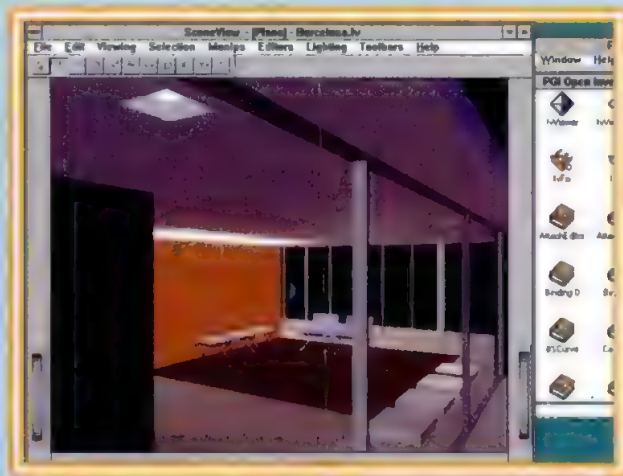


Figure 4

Figure 2 Test: Dynamic Simulation. Software: TGS Open Inventor. Demo: SGI's Slotcar.

Figure 3 Test: Rotate Complex Object. Software: AVS/Express. Model: Molecule, 400 spheres.

Figure 4 Test: Architectural Fly-Through. Software: Portable Graphics Open Inventor. Model: Barcelona, 5,338 triangles.

Figure 5 Test: Rotate Textured Objects. Software: Portable Graphics Open Inventor. Model: 12 Spheres, 2,400 triangles.

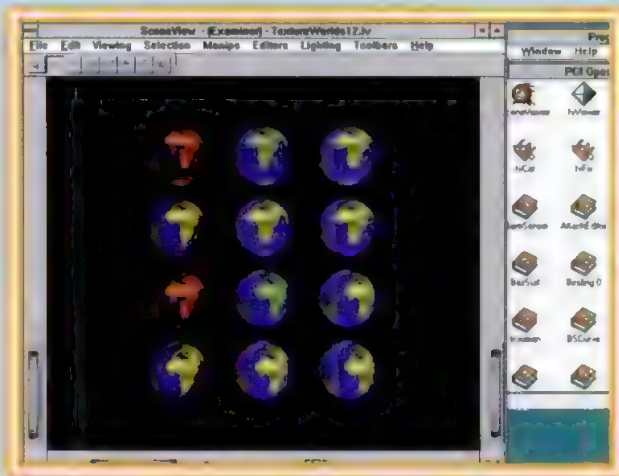


Figure 5

er. Such a configuration can be used either to improve performance in a single display system or to support a virtual world across multiple displays, as in a panoramic display.

The 2SX shows particular prowess for fly-throughs, texture mapping, and interactive simulation. It really shines in 640-by-480 15-bit color mode (or in a partial-screen render window at higher resolutions), scoring at the front of the pack on our fly-through, interactive simulation, texture mapping, and transparency tests.

The Sapphire 2SX's low-resolution performance makes it eminently suitable for VR work and dynamic simulations. But it's no slouch on other tasks. The 2SX can handle modeling and animation, CAD, and visualization. For VR developers this is particularly good news, since the 2SX will serve them during the initial design phases of a VR project and then act as the real-time engine for deployment.

Fujitsu carried many of the 2SX's strengths over to its newer, more affordable Sapphire 3D Designer. It delivers 2MB of VRAM and 4MB of DRAM (as opposed to the 2SX's 4MB-by-4MB configuration), which means limitations in

the video modes it supports with full double buffering. If you and your applications can live inside a 640-by-480 or 800-by-600 display, the 3D Designer can save you a great deal of money. It is ideal for those seeking to accelerate their VRML Web browsers for surfing the Internet in 3-D.

The 3D Designer's test results were generally in the middle of the pack though in several cases performance exceeded that of boards costing three times as

SAPPHIRE 3D DESIGNER	
SUITABILITY TO TASK	
Visualization	Fair
3-D Cad/CAE	Good
Virtual reality	Excellent
3-D animation	Good
2-D CAD	Fair

much. With good support for textures, transparency, and fly-throughs, the Sapphire 3D Designer is a cost-effective solution for virtual reality and simulation applications.

The 3D Designer is accompanied by superb documentation that belies its entry-level price. The user guide describes in informative detail the Design-

er's special features and user-customizable parameters, including the color-space double buffering offered on the Sapphire 2SX. Hardware installation was plug-and-play, requiring no jumpers and no DIP switch settings. Fujitsu plans on expanding the 3D Designer line with additional memory options and a planned Pro series with the 3D Labs Delta geometry coprocessor, the same chip that powered the Symmetric Glyder 16 to the top of our charts.

The Sapphire 2SX is an excellent all-around performer with a knack for VR and simulation work. If you're looking for such a combination you should seriously consider the Sapphire 2SX. If you're looking for an accelerator for 3-D Web browsing with VRML, simulation, virtual reality, visualization, or even CAD tasks that seldom require the highest video modes, then the Sapphire 3D Designer is your admission ticket to the world of 3-D—a ticket with a bargain matinee price.

Sapphire 2SX. List price: \$1,989. **Sapphire 3D Designer.** List price: \$1,295. Fujitsu Microelectronics Inc., San Jose, CA; 800-558-2494, 408-922-9149; <http://www.fmi.fujitsu.com>. Circle 517 on reader service card.

SUMMARY OF FEATURES

High-End 3-D Graphics Accelerators

PC MAGAZINE
EDITORS' CHOICE

■ YES □ NO

Products listed in alphabetical order

	AccelGraphics AccelR8	Diamond FireGL	Dynamic Pictures V192 Graphics Acceleration Module	ELSA GLoria 8	Fujitsu Sapphire 2SX	Fujitsu Sapphire Oki 3D Designer	TrianGL 16P
List/street price	\$1,295, \$1,295	\$1,995, \$1,995	\$4,200, \$4,000	\$2,849, \$2,600	\$1,989, \$1,595	\$1,295, \$995	\$1,690, \$1,392
2-D graphics do not require separate VGA controller	■	■	■	■	■	■	■
2-D chip manufacturer and model	None	S3 Vision968	Cirrus Logic GD5428	S3 Vision968	None	None	Proprietary
Display memory	2MB VRAM	8MB VRAM	16MB VRAM	8MB VRAM	4MB VRAM	2MB VRAM	7MB VRAM
3-D rendering chip manufacturer and model	3D Labs Glint 300SX	3D Labs Glint 300SX	Proprietary	3D Labs Glint 300SX	3D Labs Glint 300SX	3D Labs Glint 300SX	Proprietary
Geometry processor chip	None	None	None	None	None	None	None
Z-buffer memory	2MB DRAM	8MB DRAM	8MB VRAM	8MB DRAM	4MB DRAM	4MB DRAM	3MB DRAM
Z-buffer bit depths supported	16, 24*	16, 32	24	32	16, 24, 32	16	16
Accelerated double-buffered color depths (bits):							
640 x 480	8	8, 16, 24, 32	24	8, 15, 24	8, 12, 15, 24	8, 12, 15	8, 16
800 x 600	8, 16	8, 16, 24, 32	24	8, 15, 24	8, 12, 15, 24	8, 12, 15	8, 16
1,024 x 768	8	8, 16, 24, 32	24	8, 15, 24	8, 12, 15	8	8, 16
1,280 x 1,024	N/A	16	24	8, 15	8	N/A	N/A
1,600 x 1,200	N/A	16	N/A	8, 15	N/A	N/A	N/A
3-D Functions and API Support							
Supports flat-shaded polygons/Phong shading	■ □	■ ■	■ □	■ ■	■ ■	■ ■	■ ■
Supports anti-aliasing/alpha blending	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Supports stencil/log/clipping	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Accelerates transparency	■	■	■	■	■	■	■
Texture assist	■	■	■	■	■	■	■
Drivers and Software							
OpenGL drivers available for:							
Intel Windows NT 3.5/Windows 95	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
MIPS Windows NT 3.5	■	■	■	■	■	■	■
DEC Alpha/PowerPC Windows NT 3.5	■	■	■	■	■	■	■
2-D drivers for Windows NT	■	■	■	■	■	■	■
2-D drivers for Windows 95	■	■	■	■	■	■	■
2-D drivers for OS/2 3.0	■	■	■	■	■	■	■
Autodesk AutoCAD Support							
Includes Windows NT 3.5 AutoCAD driver	■	■	■	■	■	■	■
Supports AutoDesk's Heidi	■	■	■	■	■	■	■
Supports AutoCAD bird's-eye zoom	■	■	■	■	■	■	■
Supports AutoCAD text window	■	■	■	■	■	■	■
Customer Support							
Warranty	3 years	3 years	1 year	3 years	3 years	3 years	3 years
Technical-support hours (eastern time)	9:00-5:00 M-F	8:00-10:00 M-F, 11:00-7:00 Sat	10:00-8:00 M-F	11:00-9:00 M-F	11:00-9:00 M-F	11:00-9:00 M-F	9:00-6:00 M-F
Web address (http://_____)	www.accel .graphics.com	www.diamondmm .com	www.dypic.com	www.elsa.com	www.fmi. .fujitsu.com	www.fmi. .fujitsu.com	www.oki.com

* With memory upgrade. N/A—Not applicable. The product does not have this feature.

Oki Advanced Products

TrianGL 24P, TrianGL 16P

The Oki TrianGL 24P (\$2,795 list, \$2,200 street) and TrianGL 16P (\$1,695 list, \$1,400 street) accelerator cards were designed with a tight focus on the 3-D CAD user looking for a PC alternative to an entry-level workstation. The two TrianGL boards returned mixed results on tests related to 3-D CAD, some-

times competitive with the GLyder 16, the best on our tests, then falling below average on other tests. A surprise to us as well

as Oki, both boards excelled on our 2-D AutoCAD tests.

These boards, based on Oki's own graphics engine, differ in the amount of memory they deliver. The TrianGL 24P comes equipped with 3.75MB of DRAM, while the 16P comes with 3MB—which means you'll have to decide between high resolution and high color depth.

Because of Oki's specific market focus, we oriented our analysis to 3-D CAD at 1,024-by-768 resolution. Tests outside this

TrianGL 24P	
SUITABILITY TO TASK	
Visualization	N/A
3-D Cad/CAE	Fair
Virtual reality	N/A
3-D animation	N/A
2-D CAD	Good

High-End Graphics Boards

using a TrianGL for these functions. One exception: On our simulation test, the TrianGL 24P delivered speed competitive with our top performers.

The performance anomalies we saw disturbed us. For example, the TrianGL 24P performed acceptably on our architectural fly-through test in 1,024-by-768 24-bit color mode. But when we dropped back to 16-bit color depth, performance got worse rather than better.

We did discover the TrianGL boards to be exceptional 2-D AutoCAD performers, panning, zooming, erasing, and regenerating within seconds of our top AutoCAD performer, the ELSA GLoria. Be warned that 3-D CAD with complex models, as shown by our Rotate Complex Object test, will be less than acceptable. Oki reports that the boards are meant to reduce the cost of a 3-D CAD seat for simple design automation tasks and particularly for design review—not for designing a jumbo jet.

Buried in the Oki TrianGL accelerators is a high-performance engine that shows through on some tests and vanishes on others. Check it out with your specific app to see if it's strong where you need it. **TrianGL 16P.** List price: \$1,695. **TrianGL 24P.** List price: \$2,795. Oki Advanced Products, Oki America Inc., Marlborough, MA; 508-624-7000; <http://www.oki.com>. Circle 519 on reader service card.

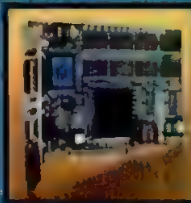
Omnicom Inc.

3Demon SX88

Omnicom has been shipping Glint-based accelerator cards for the PC longer than any other vendor, and the 3Demon SX88 (\$2,295 list, \$1,960 street) shows it in the depth of its documentation, its ease of installation, and its driver support and special features. But this design is also showing its age: While the 3Demon is balanced and usable, it lags behind other Glint-based offerings from newcomers.

Special features abound. The 3Demon supports dual monitors and color-space double buffering for improved animation performance at 12 bit color depth. It also deliver Windows NT event logging to help you optimize your configuration. In addition to OpenGL, the 3Demon supports Argonaut's Brender 3D APIs, Microsoft RealityLab, and Criterion's RenderWare.

3Demon SX88	
SUITABILITY TO TASK	
Visualization	Fair
3-D Cad/CAE	Fair
Virtual reality	Good
3-D animation	Good
2-D CAD	Fair



The current 3Demon requires the use of a supplied external pass-through cable that connects to your existing VGA card or port. Once connected, the 3Demon installed without a hitch. The included documentation is extensive and provides detailed information on variables used to tune performance.

During testing, the 3Demon scored neither poorly nor exceptionally at any task. It turned in usable performance for tasks that required transparency, texture assist, and smooth shading. The board should prove competent for visualization and 3-D CAD uses, and good for 3-D animation and VR chores that don't require strong performance at higher resolutions. There is no double-buffered support for 1,280-by-1,024 24-bit true color, though Omnicomp is readying a new line of accelerators based on 3D Labs Glint 300DSX, incorporating the Delta geometry preprocessor.

If you're looking for an accelerator vendor with both a past and a future, Omnicomp should be on your list.

3Demon SX88. List price: \$2,295. Omnicomp Inc., Houston, TX; 800-995-6664, 713-464-2990; <http://www.phoenix.net/~omnicomp>. Circle 521 on reader service card.

Symmetric Inc.

Glyder 16



The Glyder 16, from Symmetric, is a high-end graphics board that excels at every 3-D task you send its way. Competitively priced at \$2,695 (list), this Editors' Choice winner was the most consistent performer in our group, whether for visualization, engineering, animation, or virtual reality and simulation.

Installation was straightforward. No jumpers or switches need to be set. The documentation is brief but accurate, and has some welcome hints at optimizing Glyder performance both generally and

PC MAGAZINE
EDITORS' CHOICE

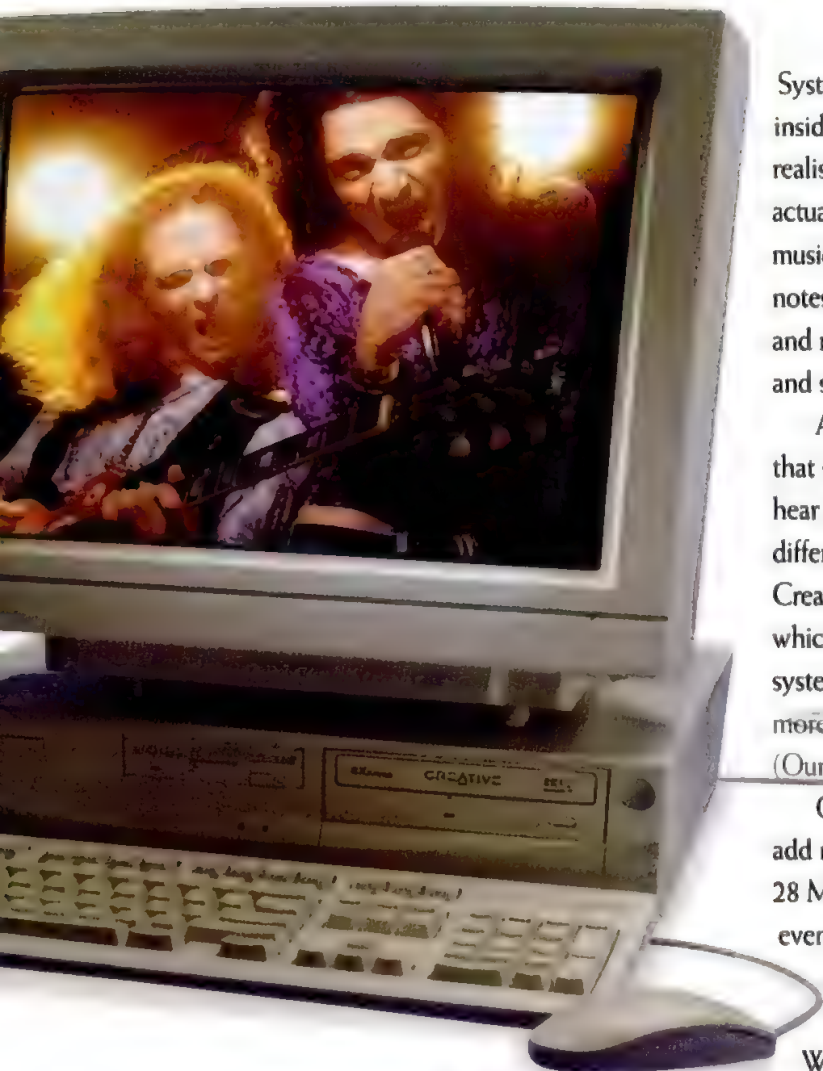
Oki TrianGL 24P	Omnicom 3Demon SX88	Symmetric Glyder 16
\$2,799, \$2,199	\$2,295, \$1,959	\$2,695, \$2,695
Proprietary	None	Avance Logic
13MB VRAM	8MB VRAM	8MB VRAM
Proprietary	3D Labs Glint 300SX	3D Labs Glint 300SX
None	None	Glint Delta
3.75MB DRAM	8MB DRAM	8MB DRAM
24	32	16, 24, 32
8, 16, 24	8, 12, 16, 24/32	8, 12, 15, 24
8, 16, 24	8, 12, 16, 24/32	8, 12, 15, 24
8, 16, 24	8, 12, 16, 24/32	8, 12, 15, 24
8, 16, 24	8, 12, 16	8, 12, 15
N/A	8, 12, 16	8, 12, 15
3 years	3 years	3 years
9:00-6:00 M-F	8:30-6:30 M-F	10:00-7:00 M-F
www.oki.com	www.phoenix.net/~omnicomp	www.symmetric.com

purview, at lower resolutions and for transparency and texture, returned the low values expected. Don't even think of

TrianGL 16P	
SUITABILITY TO TASK	
Visualization	N/A
3-D Cad/CAE	Fair
Virtual reality	N/A
3-D animation	N/A
2-D CAD	N/A



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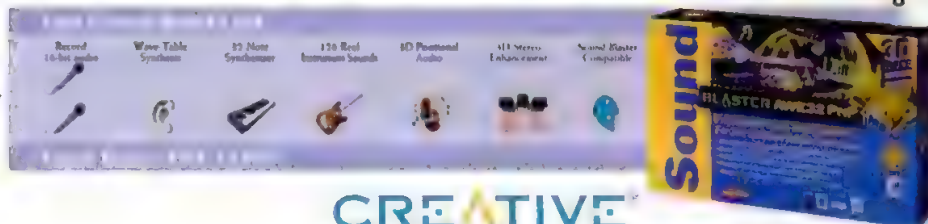
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with Pro/Engineer, Microstation, Open Inventor, and I-DEAS 3D applications. The board also supports color-space double buffering for better animation performance without resorting to lowly 8-bit color.

The GLyder dominated our tests, thanks to its 3D Labs' Glint 300SX and new Delta coprocessor (it was the only board here to have the new chip). Geometry acceleration has been a hallmark of the high-end of professional graphics workstations such as the SGI Onyx Reality Engine/2. The Delta chip brings this concept down to the PC, offloading many geometry processing tasks that hamstring an Intel CPU.

The GLyder is a balanced performer, capable of maintaining a very high frame rate while handling transparency, texture mapping, rotations, translations, and scaling. While other boards showed one or two performance bright spots, in 1,024-by-768 24-bit color mode the GLyder was consis-

GLyder 16	
SUITABILITY TO TASK	
Visualization	Excellent
3-D Cad/CAE	Good
Virtual reality	Excellent
3-D animation	Excellent
2-D CAD	Fair

tently at the top of the performance heap.

The GLyder also exhibits usable performance even when coupled with a Pentium/100. The GLyder performed the Rotate Simple Object, Rotate Complex Object, Rotate Transparent Object, and Architectural Fly-Through Tests (at 640-by-480) on our HP Vectra 5/100 with aplomb. This means a GLyder can make for an effective entry-level 3-D solution coupled with a Pentium and later be moved into a Pentium Pro machine.

By the time you read this, Symmetric will also be offering the even more affordable GLyder 8 for those who don't need the highest resolutions and color depth modes. Symmetric is also planning a model built around the forthcoming Glint 300TX. For now, Symmetric has an outstanding offering for the professional 3-D user. To paraphrase the airline, the Delta-equipped GLyder loves to fly, and it shows. □

GLyder 16. List price: \$2,695. Symmetric Inc., Dallas, TX; 214-931-5999; <http://www.symmetric.com>. Circle 522 on reader service card.

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PC Tech

THE DEFINITIVE GUIDE TO PC TECHNOLOGIES & TOOLS

WinHelp 4: Windows 95's Enhanced Help System

Build a help system for your Windows 95 app—five new tools give you all the help you need.

By Neil J. Rubenking

Help! That's what you need when your new Windows application won't behave. It's reassuring to know you can always click on the Help menu. Each time you do, you're relying on WinHelp, the Help utility supplied with Windows. WinHelp 4, the latest version designed for Windows 95 and shared with Windows NT 3.51, has quite a few new features. In this article, we'll explore the highlights of these features before taking a look at five of the Help design tools that support them: Doc-To-

Help 2.0, ForeHelp 2.95, Help Magician Pro 95, RoboHelp 95, and HelpBreeze 2.0.

WinHelp 4 has a new look. In fact, it has a completely remodeled entrance. In earlier versions, the Help menu's standard items were "Contents," "Search for Help On," and "How to Use Help." All three are replaced in WinHelp 4 by a single item, "Help Topics," which brings up the Contents log.



IN THIS SECTION



TUTOR Long filenames are finally possible in Windows—thanks to Windows 95. But because compatibility with earlier versions of the operating system was a mandate for the designers of Windows 95, the long-filename feature is somewhat compromised. Find out what you need to know in order to use long filenames effectively and to avoid unwanted surprises. *page 217*



INTERNET TOOLS Even if you're a beginning Web publisher, you'll discover lots of good reasons to include images in your online documents.

Here we explore the common Web image formats and suggest techniques to help you create efficient yet stunning graphics for your Web documents. *page 221*



LAB NOTES With this issue's PC reviews, PC Magazine Labs introduces Winstone 32, the new 32-bit benchmark test program developed by the Ziff-Davis Benchmark Operation. It's designed to measure a PC's performance when running the new generations of 32-bit Windows applications. *page 229*



UTILITIES A PC version of a new board game that's destined to become a classic. Pit your wits against the computer by trying to form a square with your pieces while blocking the PC from doing so. The game sounds simple but involves a good deal of strategy. Also learn how the game was programmed using Borland's visual programming tool, Delphi. *page 234*

FEATURES PLUS For our article on Windows 95 Help authoring tools, we reviewed five products. In conjunction with the article, contributing technical editor Neil J. Rubenking leads an online discussion from June 10 to 14, with representatives from the vendors of Doc-To-Help, ForeHelp 2.1.1, HelpBreeze, ProtoView Visual Help Builder, RoboHelp 95, Help Magician Pro 95, and WYSI-Help. To join the discussion, just type GO EDITOR at a CompuServe prompt.

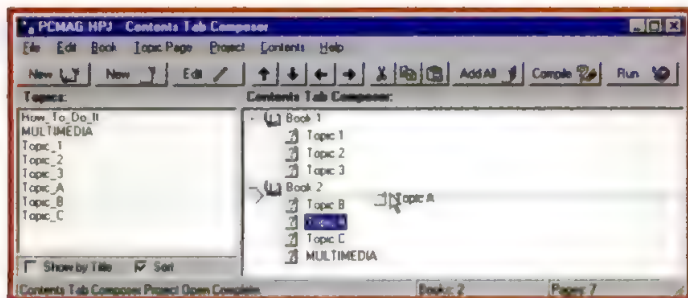


FIGURE 1: A Help system's Contents tab organizes topics into a hierarchy; here, the Contents tab is being organized in RoboHelp 95.

This three-page tabbed dialog is the entry to every WinHelp 4 Help system. The Contents tab lays out the Help-system hierarchy, the Index tab is similar to the familiar keyword search dialog, and the Find tab enables a full-text search of the Help system.

The Contents tab is a tree-structured arrangement of "books" and "topics." Each book holds one or more topics and may also hold other books. Figure 1 shows a Contents tab being modified in RoboHelp 95's Contents Tab Composer. Double-clicking a book opens or closes it, and double-clicking a topic jumps to that topic in the Help system. The contents page can seamlessly integrate multiple Help files, displaying each one as a book.

The Index page goes beyond the traditional topic-search dialog by permitting two-

level keywords, with subkeys that refine the meaning of a main index keyword. For example, the main keyword *mammals* might have the subkeys *primates* and *ungulates*. Of course, the user's ability to find a topic based on keywords depends entirely on the

NEW WINDOW TREATMENTS

Help-system designer's expertise in specifying logical keywords. When the Index page fails, the Find page permits a full-text search of the Help system. Help designers rarely supply a full-text index along with the Help file, because WinHelp 4 automatically creates the index the first time it's needed.

buttons that trigger actions in the program.

The other prominent new window type is the context-sensitive Help panel, or "What's This?" window (Figure 2). In many Windows 95 programs, you can get a brief description of an on-screen element by right-clicking it and choosing "What's This?" from the menu, by selecting it and pressing F1, or by clicking it after clicking the question-mark icon on the title bar.

WinHelp 4 gives the Help designer more freedom to create secondary Help window classes: Procedural topics usually reside in a secondary window, as do other frequent tenants like glossaries and examples. A Help system can have as many as 255 different secondary-window classes, and individual topics can be linked to a specific window style. Secondary windows can now have toolbar buttons as well. The designer can specify the window's relative size and screen location and optionally make it adjust its height to fit the topic.

BUTTONS, MACROS, AND ART

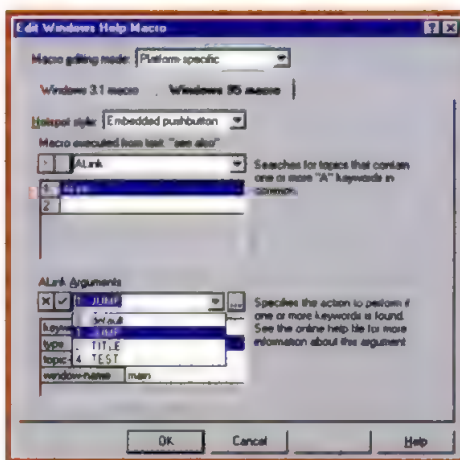
Three new types of buttons escape from the toolbar and appear in the midst of Help text (Figure 3). An *authorable* button looks like an ordinary push button, except that it's shorter from top to bottom and can be used as a hotspot to trigger a jump, pop-up, or macro. A *shortcut* button is a tiny square button with a picture of an arrow, like the familiar shortcuts

WEXTECH SYSTEMS INC.

Doc-To-Help

Doc-To-Help, Version 2.0, produces both printed documentation and a Help system from a single source. Doc-To-Help uses the Microsoft Word document's hierarchy of headings to define topics and jumps in the Help file. This is especially beneficial in WinHelp 4, as Doc-To-Help also uses the hierarchy to define the Contents tab. To create our six topics and two books, we simply formatted the book names and topic names with Header 1 and Header 2 styles. A separate browse sequence for each book was created automatically, as Doc-To-Help defaults to starting a new sequence at each Header 1 line.

Doc-To-Help assigns index entries (which become keywords) based on a user-specified list of target phrases and insertion options. A-keywords are not directly supported, but we were able to create them by inserting appropriately formatted footnotes. Secondary windows are associated with topic types; the list of default types can be seen in Figure 2. With a few minor changes, the Procedural type matched our specification.



Doc-To-Help's macro-editing dialog provides on-screen help for macros and their arguments. In some cases, it provides a drop-down list of possible values.

By the time you read this, Doc-To-Help should support mini and shortcut buttons; we substituted authorable buttons for testing purposes. To create each WinHelp 4 macro, we endured a three-step process, confirming our need for platform-specific code. The macro-editing dialog—shown here—proved excellent once we reached it: The dialog provided on-screen help for each macro and its arguments, including, wherever possible, a drop-down list of values. Macro creation went smoothly, as did embedding the .AVI file. Compiling even this eight-topic project into a Help file, however, required a lengthy conversion process. Though it can be used for any Help system, Doc-To-Help is best suited for large projects that follow the same structure as a printed manual.

Doc-To-Help 2.0. List price: \$395. Requires: 8MB RAM (16MB recommended), 10MB hard disk space, Microsoft Word 7.0. WexTech Systems Inc., New York, NY; 800-939-8324, 212-949-9595; fax, 212-949-4007; <http://www.wextech.com>. Circle 491 on reader service card.

on your Windows 95 desktop. This type of button usually performs a task for the user. And a *mini* button is a tiny blank square that optionally has text beside it. "See also" lists of related topics are often invoked from mini buttons.

WinHelp 4 defines over 30 new macros. Many of these simply enhance existing macros, but some add exciting new capabilities. Table 1 lists 12 of the most interesting additions.

The KLink macro displays a list of topics that share one or more specified keywords. The ALink macro does the same thing, but it uses A-keywords—a new type of hidden keyword that does not appear in the index. Both are normally used for the automatic display of related topics. Due to a bug in WinHelp 4, an ALink or KLink macro that uses multiple keywords will list a topic once for each matching keyword, appending the Help filename to the repeated references. Thus, it's best to use these macros with a single keyword.

Calling the InitMPrint macro displays the Printer Setup dialog and prepares WinHelp 4 for printing multiple topics (another new feature). MPrintID prints an individual topic, and EndMPrint terminates the process of printing multiple topics.

A Help system can invoke the Find tab of

the Help Topics dialog by calling the Find macro; the existing Contents and Search macros invoke the dialog's Contents and Index tabs. The Finder macro brings up the Help Topics dialog with whatever tab was previously active. And you can trigger WinHelp 4's right-click context menu by calling the Menu macro.

The remaining macros in the dynamite dozen all involve actions outside of WinHelp. ExecFile replaces the old ExecProgram macro. It executes a program or a document associated with a program, and it can trigger an error message topic within the help system if it fails. ShellExecute *should* do the same, plus add the option to control the working directory and choose whether to open the file or to print it. Unfortunately, a bug in ShellExecute's implementation causes it to fail if these added abilities are used.

If you've used the Troubleshooting topics in Windows 95's own Help, you've seen the ControlPanel macro in action. This macro invokes a control panel applet and opens it to a particular tab. There is one catch: The three

A SELECTION OF WINHELP 4'S NEW MACROS

Macro	Effect
KLink	Finds topics related via K (normal) keywords.
ALink	Finds topics related via A (hidden) keywords.
InitMPrint	Initializes multiple-topic printing.
MPrintID	Prints a topic.
EndMPrint	Terminates multiple-topic printing.
Find	Displays the Find tab in the Help Topics dialog.
Finder	Displays the Help Topics dialog.
Menu	Displays the right-click context menu.
ExecFile	Launches a program or document file.
ShellExecute	Opens or prints the specified file.
ControlPanel	Launches a control-panel applet; opens it to a specific tab.
ShortCut	Activates a program and sends it a WM_COMMAND message.

parameters to ControlPanel are officially listed as the .CPL file name, the applet name, and the zero-based tab number. In practice, the tab number, preceded by a comma, must be appended to the applet name. So, for example,

```
ControlPanel("desk.cpl", "Display", 1)
```

is officially correct, but

```
ControlPanel("desk.cpl", "Display,1")
```

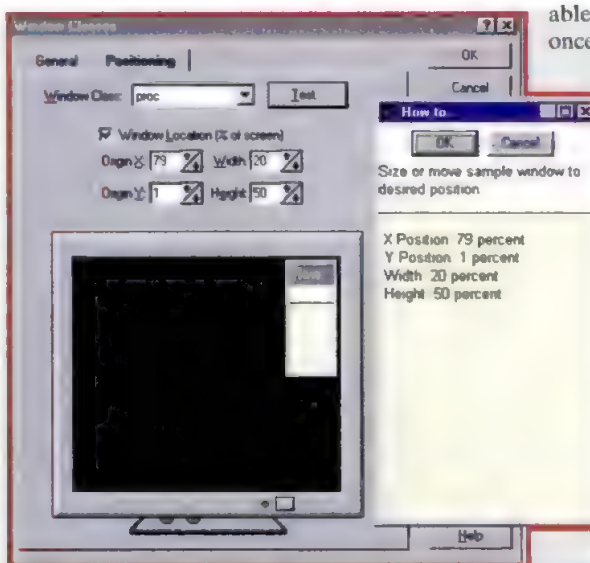
is what actually works.

FOREFRONT INC.

ForeHelp

ForeHelp 2.95's design window is as similar to WinHelp's own screen as can be (Figure 3). Creating our six topics was a snap, and they all looked like Help topics right away. The Topic Keywords dialog allowed us to set the two-level keywords and the invisible A-keywords all at once. The Browse Sequence editor uses a clear drag-and-drop interface, and topics are grayed once they've been added to a sequence. The Browse Sequence editor even includes a button to add all unused topics to the current sequence. The Contents File editor has a similar interface, though it provides no easy way to determine whether a given topic has been added to the Contents File yet.

You can easily create secondary window classes, and, as you can see, you can adjust the screen-relative size of a secondary window using a real window on the full screen. We were



You can define a secondary window's size and position in ForeHelp using either the pictured screen in the Window Classes dialog or the screen itself.

able to add all three types of buttons once we realized that ForeHelp refers to the shortcut button as a type of bullet. The macro editor tracks separate macro parameters, but macro help and parameter definitions aren't built into it. We found the "macro set" feature handy: Define an existing series of macro commands as a set, and you can reuse that set elsewhere in your Help system.

ForeHelp is an excellent tool for the visually-oriented designer. Buttons, .AVI files, and just about all Help-system features appear at design time, and most of them are functional in the extremely fast test mode. As long as you don't want to play .AVI files or run advanced macros, test mode emulates WinHelp quite well, without the need to compile and run the project.

ForeHelp 2.95. List price: \$395. Requires: 4MB RAM (8MB recommended), 6MB hard disk space. ForeFront Inc., Boulder, CO; 800-357-8507, 303-499-9181; fax, 303-494-5446. Circle 492 on reader service card.

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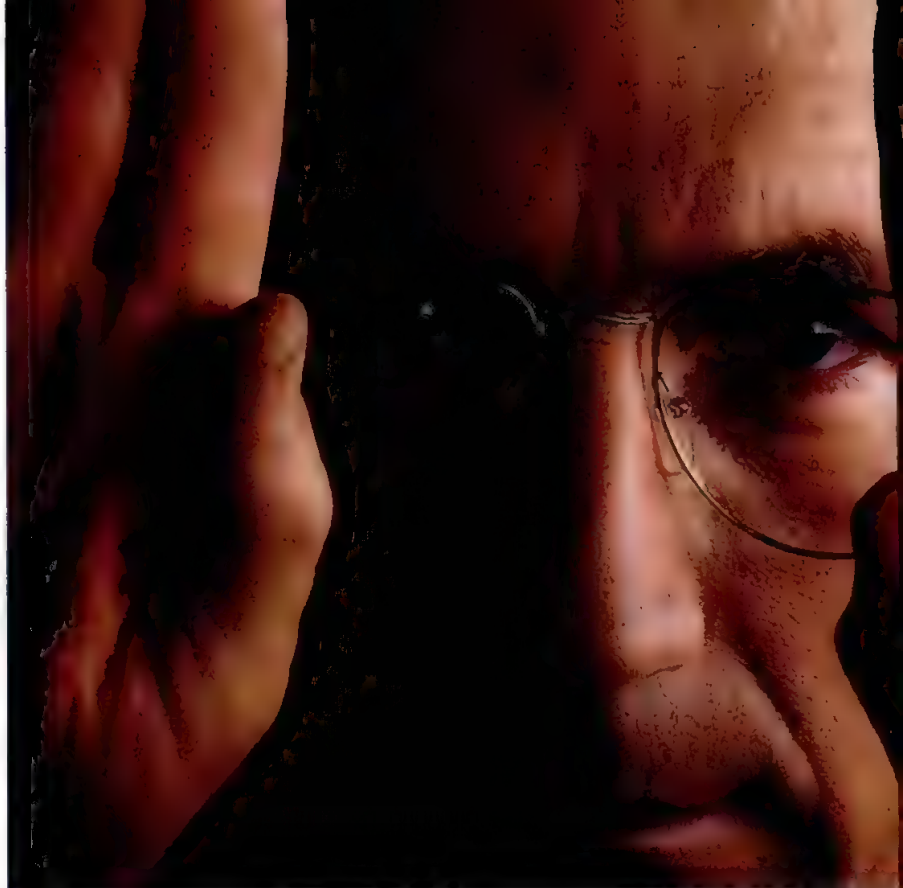
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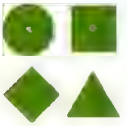
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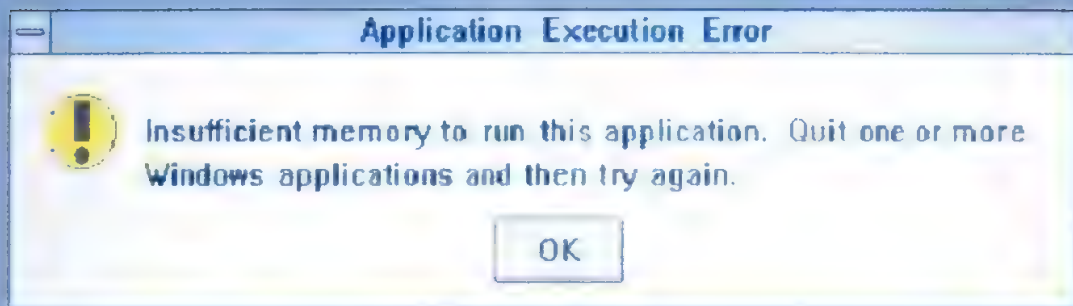
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The Shortcut macro has even more power—it will activate or launch a specified program (usually the application described in the Help file) and send it a menu command. Figuring out the ID number for a menu command in a program you didn't write can be difficult, but one of the design tools handles even this task for you.

You could use 256-color graphics in the previous version of WinHelp, but it took some work. WinHelp 4 permits bitmaps in 256-color or in 24-bit color. Similarly, adding video and sound files had been possible but tedious; now, it's automatic. For nonrectangular images, bitmaps can define a "transparent" color to let the background show through. And the Help compiler itself includes a dozen or so small, default bitmaps.

THE TOOLS

It's possible to create a Help system by embedding special codes in a Rich Text Format (.RTF) document, then compiling it with Microsoft's Help Compiler. It's also possible to dig a hole in a slab of granite using a rusty spoon. Luckily, tools for the Help-system designer abound. We looked at five that support WinHelp 4. They fall into two groups: those that rely on Microsoft Word, and those that stand alone. Doc-To-Help, RoboHelp 95, and

HelpBreeze all use Word to generate the .RTF file that defines a Help system. These tools integrate their commands into Word's menu and add toolbars for Help-specific actions. Help Magician Pro (currently in beta testing) and ForeHelp are independent; you don't have to buy Microsoft Word. The aim of these packages is to make the Help design environment look as much like the final Help system as possible.

All of the products examined here can create Windows 3.x Help systems, but to generate WinHelp 4 Help systems, they require either Windows 95 or Windows NT 3.51 or later. Those products that rely on Word require Version 7.0; RoboHelp can optionally use the 32-bit Windows NT version of Word 6.0.

To test the suitability of these tools for designing WinHelp 4 Help systems, we devised a simple set of tasks using features specific to WinHelp 4:

- Create six Help topics, each with two-level keywords.
- Put two books on the Contents page and add three of the topics to each one.
- Create two browse sequences correspond-

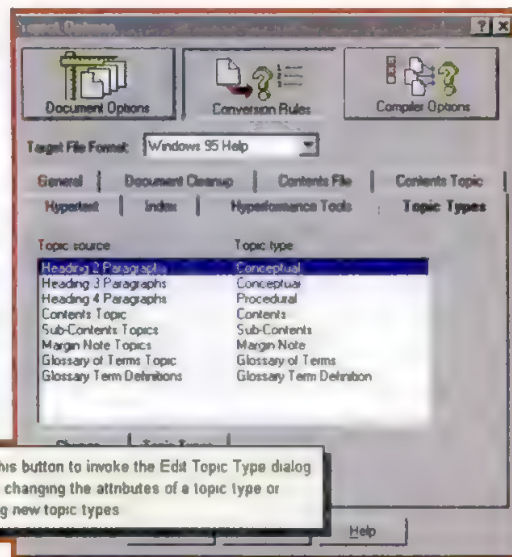


FIGURE 2: Many Windows 95 applications offer "What's This?" floating help panels like this one.

ing to the two books.

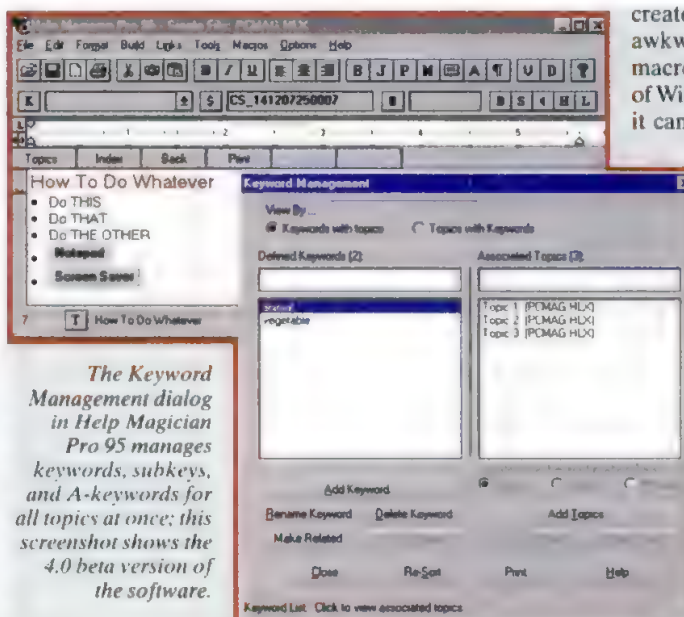
- Add the hidden A-keyword *Odd* to the first, third, and fifth topics.
- Define a secondary-window class for procedural topics with a pale-yellow background and the toolbar buttons Help Topics and

SOFTWARE INTERPHASE INC.

Help Magician Pro 95

Help Magician Pro 95 (currently in a 4.0 beta version) is, like ForeHelp, a standalone, WYSIWYG Help design tool. In the beta version we examined, most of the WinHelp 4 enhancements were implemented. As you can see, the Keyword Management feature conveniently allowed us to assign keywords to several topics at once (although two-level keywords and A-keywords were not enabled in the beta version). Also like ForeHelp, Help Magician permits setting secondary window size and position using an actual window on the full screen.

The finished product will support mini and shortcut buttons; we substituted authorable buttons for testing purposes. Selecting a keyword as the jump destination automatically inserts an ALink or KLink macro. Before you use a WinHelp macro in Help Magician, you must



The Keyword Management dialog in Help Magician Pro 95 manages keywords, subkeys, and A-keywords for all topics at once; this screenshot shows the 4.0 beta version of the software.

create a macro definition. This seems awkward for single macros, but a macro definition can include a series of WinHelp macros, and once created, it can be used throughout the Help system. Our Notepad and Screen Saver macros were successful, but attempts to add an .AVI file crashed the beta software. The finished product, scheduled for release in May, will please those who want a WYSIWYG Help design tool; it will also support the creation of Web pages directly from Help-system source code. And if you're new to Help designer, the Help Wizard will lead you through the process one simple step at a time.

Help Magician Pro 95 (4.0 beta). List price: \$249. Requires: 8MB RAM, 10MB hard disk

space. Software Interphase Inc., Foster, RI; 800-542-2742, 401-397-2340; fax, 401-397-6814; <http://www.sinterphase.com>. Circle 493 on reader service card.

BLUE SKY SOFTWARE CORP.

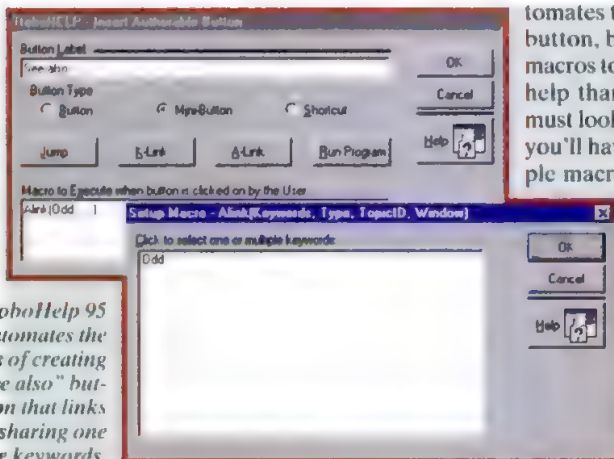
RoboHelp 95

Blue Sky Software updated RoboHelp 95 for WinHelp 4 even before the Windows 95 launch. Although RoboHelp relies on Microsoft Word, its floating toolbar and numerous dialog boxes emphasize that RoboHelp is in charge. The current version, Revision A, adds the ability to create Windows 3.x Help systems.

We created our six topics and entered the two-level keywords and A-keywords, all in the Help-topic-creation dialog. Using the drag-and-drop Contents Tab Composer (shown in Figure 1), we easily created two books and added three topics to each. On the other hand, setting up a second browse sequence was surprisingly difficult, requiring us to edit each topic in the second sequence.

As the screenshot here illustrates, the button-editor dialog au-

RoboHelp 95 automates the process of creating a "see also" button that links topics sharing one or more keywords.



tomates the process of creating a "see also" button, but when you're adding a series of macros to a button, RoboHelp gives you less help than any of the other products. You must look up the necessary parameters, and you'll have to remember to separate multiple macros with colons or semicolons, depending on how the macro is to be invoked.

AVI file insertion went smoothly, and when we deliberately introduced an error, RoboHelp's error wizard explained the problem in detail. Alone or as a part of Blue Sky's WinHelp Office suite, RoboHelp is a thoroughly professional product that represents years of development.

RoboHelp 95, Revision A. List price: \$499. WinHelp Office: Introductory price, \$599; \$866 thereafter. Requires: 8MB RAM, 8MB hard disk space, Microsoft Word 7.0. Blue Sky Software Corp., La Jolla, CA; 800-677-4946, 619-459-6365; fax, 619-459-6366; <http://www.blue-sky.com>. Circle 495 on reader service card.

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Options. This window must adjust to the height of the topic and appear at the right side of the screen.

- Create a procedural topic that uses the secondary window defined in the previous step.
- Add a “see also” mini button to the first, third, and fifth topics; each button should trigger an ALink macro on the keyword *Odd*.
- Create a shortcut button that uses the Shortcut macro to open Notepad, insert the current date and time, select the text and copy it to the clipboard.
- Add an authorable button that opens the Screen Saver page of the Display control panel applet.
- Add a topic that plays a video file when opened.

Each of the shipping products handled these tasks with reasonable success. Precisely which is best for *you* will depend on other considerations. If your primary goal is to create a full-scale product manual and Help system from the same source, Doc-To-Help is clearly the best choice. If you don't have Word 7.0, or if you prefer a WYSIWYG editing environment, you should choose ForeHelp (or, when it's released, Help Magician Pro 95). Word 7.0 users who aren't concerned with

producing product manuals will choose between RoboHelp 95 and HelpBreeze. RoboHelp is a well-established product with an excellent track record and years of refinement. The less-known HelpBreeze, however, thoroughly integrates the WinHelp 4 features and costs a good bit less.

COMING ATTRACTIONS

Two other Windows 95 Help authoring tools will ship in the near future: Visual Help Builder 3.0, from ProtoView (800-231-8588), will support all of the WinHelp 4 enhancements. In addition, it will have the unusual ability to scan an application's source code and generate an appropriate Help-system skeleton. The Windows 95 version of WYSI-Help, from UDI Software (415-382-8840), should be available by the time you read this. And, of course, Help Magician Pro 95 will be shipping soon.

WinHelp 4 itself has quite a few bugs, some of which are noted in this article. It will undergo a minor update in conjunction with the release of Windows NT 4.0, but that will be the last version of WinHelp as we know it. At a recent

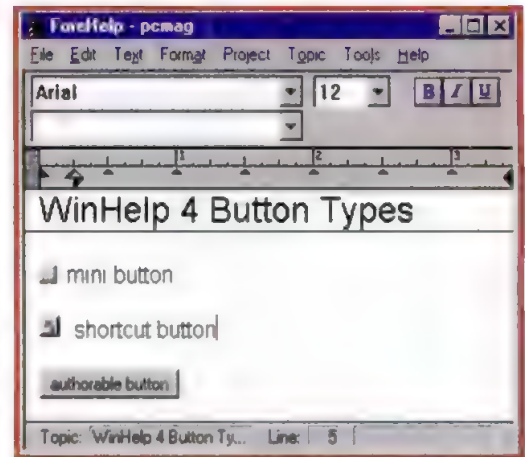


FIGURE 3: WinHelp 4 introduces three new types of in-text buttons; here, all three are displayed in ForeHelp.

WinHelp conference, Microsoft revealed that the next incarnation of WinHelp will be based on HTML files (the files used to describe Web pages) rather than .RTF files. This time next year, it may be a whole new ball game. □

Neil J. Rubenking is the contributing technical editor of PC Magazine.

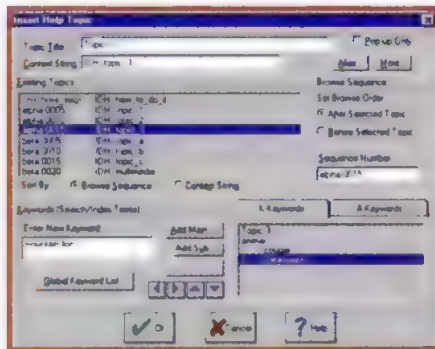
SOLUTIONSOFT

HelpBreeze

HelpBreeze, Version 2.0, adds dozens of menu choices and a substantial toolbar to Microsoft Word, and thoroughly integrates the WinHelp 4 enhancements. We created our six topics and added two-level keywords and A-keywords from the Insert Help Topic dialog (shown below). The Contents file editor was straightforward, although implemented without drag-and-drop. By the time you read this, a manual for HelpBreeze will be available. We didn't find the lack of a manual bothersome, however; we used HelpBreeze's Help system instead.

A built-in topic wizard created our secondary window and procedural topic; for fine-tuning the window's properties, the wizard launched the Microsoft Help Workshop. HelpBreeze automates the process of linking to topics related via key macro for our "see

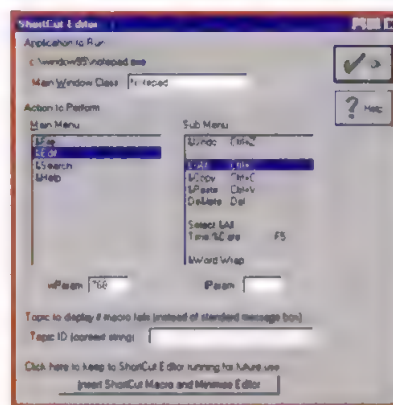
HelpBreeze's distributable WebDialer utility implements links from a Help system to the Internet. To add a Web link, you simply



When you add a Help topic in HelpBreeze, you can set the browse sequence and all of its keywords at the same time.

connect to the site, create a macro hotspot, and press the URL button. The resulting macro will connect to that URL using WebDialer.

We were amazed by the macro editor's handling of the Shortcut macro. It actually analyzed the selected program and, as the screen-



This remarkable dialog from HelpBreeze analyzes and displays the menu structure of a selected program, then generates a Shortcut macro to execute the selected menu item.

shot shows, allowed us to choose which menu item to trigger. You'll receive no assistance at all for building arguments to the other macros, however; you simply read the Help topic for the macro in question and type in the parameters. Our ControlPanel macro worked fine, as did the embedded .AVI file. If you're happy working in Microsoft Word and want to emphasize the Win-Help 4 enhance-

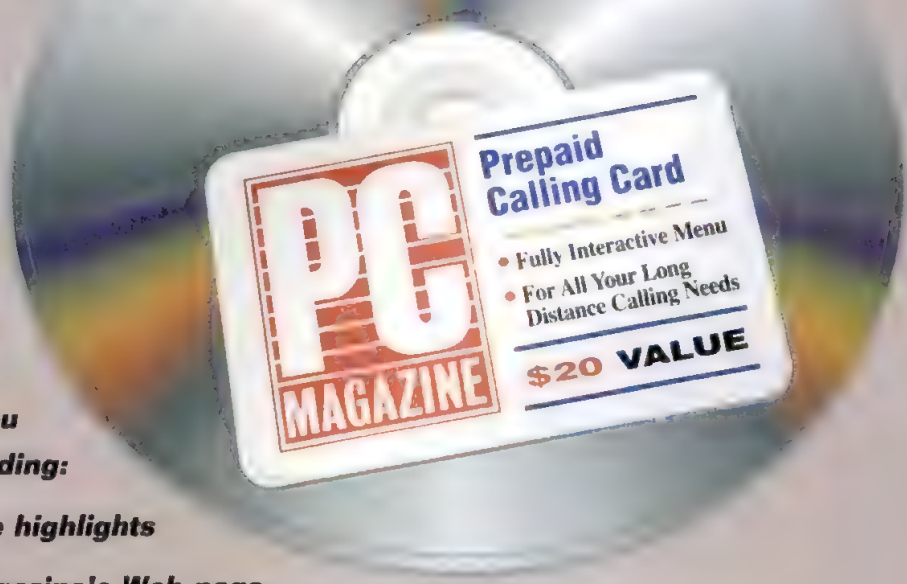
ments in your projects, HelpBreeze is a fine choice.

HelpBreeze 2.0. List price: \$349. Requires: 4MB RAM, 6.5MB hard disk space, Microsoft Word 7.0. Solutionsoft, Sunnyvale, CA; 408-736-1431; fax, 408-736-4013; <http://www.solutionsoft.com>. *Circle 494 on reader service card.*

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By Jeff Prosis

How Windows 95 Stores Long Filenames

What implications do long filenames pose for end users?

For years, DOS and Windows users have been hampered by filenames limited to eight characters plus a three-character extension. The Macintosh OS, OS/2, and Windows NT have supported long filenames for what seems like forever, but it wasn't until the debut of Windows 95 last year that mainstream Windows users finally were able to bid the 8.3 filename format good-bye.

Much has been written about the ability of Windows 95's VFAT (Virtual File Allocation Table) file system to use long filenames, but do you know how those long filenames are implemented? The on-disk storage format of 8.3 filenames is well-documented, but there has been surprisingly little information published about the internals of long filenames. That's a shame, because the need to make VFAT backward-compatible with the FAT file system forced some design compromises that have very real implications for end users. For example, did you know that there are drawbacks to using long filenames in a drive's root directory? And that if you don't defragment a drive that contains long filenames every now and then, perfectly good disk space can go unused?

To understand why, it helps to know how long filenames are implemented in Windows 95. Let's begin by looking at how the operating system stores long filenames on disk.

THE 8.3 DIRECTORY ENTRY FORMAT

Windows 95 stores short (8.3) filenames the same way DOS and 16-bit versions of Windows do. Every file on every disk is accompa-

nied by a 32-byte *directory entry* that records the name of the file as well as the file's attributes (hidden, system, read-only, and so on), a date and time stamp, and other information. When you type DIR at a command prompt to list the contents of a directory, what you see in response is a human-readable version of the information stored in that directory's directory entries.

Figure 1 documents the format of the 8.3

or last modified, the file's starting cluster number, and the file's length in bytes. The starting cluster number is a 16-bit value that identifies the first cluster containing the file's data.

Before a file is read or written, the operating system consults the file's directory entry to find the starting cluster number. If the file data occupies more than one cluster of disk space, values identifying the remaining clusters are retrieved from an on-disk data structure

called the *file allocation table*, or FAT. It is from this table that the FAT and VFAT file systems derive their names.

Directory entries for files in the root directory are stored in a special area of the disk that is set aside to hold information only about the root directory. Directory entries for files located in subdirectories are stored in special files whose own directory entries' attribute bytes have bit 4 set to identify them as subdirectories. The size of the area reserved for root directory entries is fixed when the drive is formatted and can't be changed without special software. That's why the number of files and subdirectories you can create in the root

directory is always limited to some fixed number (512 for most hard disks). Subdirectories, however, can grow just like files, so the number of files and subdirectories a subdirectory can hold is limited only by available disk space.

LFN DIRECTORY ENTRIES

Because of compatibility issues, adding long filename support to an operating system that uses 8.3 filenames isn't as simple as expanding

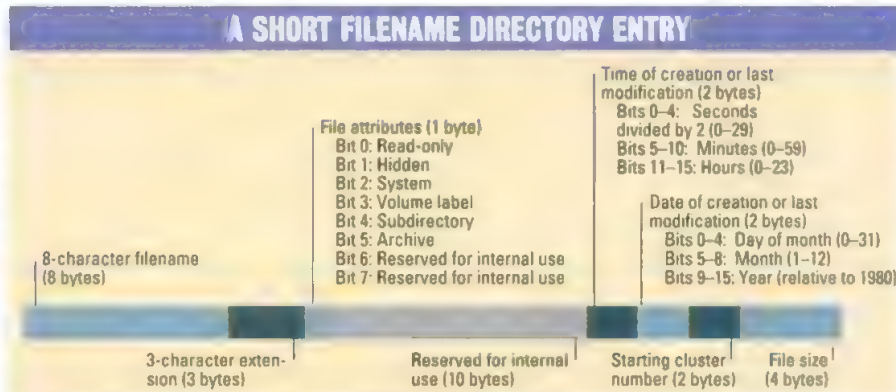


FIGURE 1: Short filenames are stored on disk in the 32-byte format.

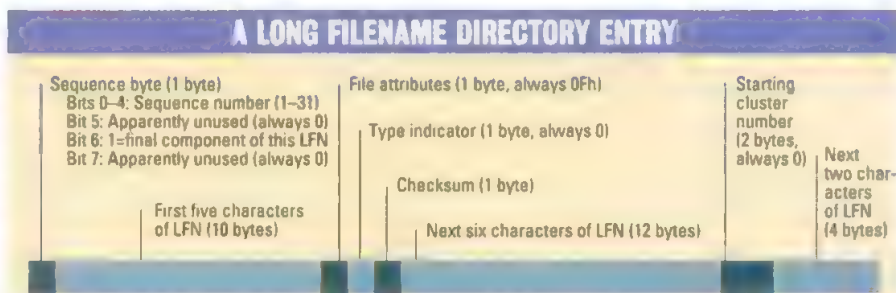


FIGURE 2: Long filenames are stored in the above format in one or more 32-byte LFN directory entries that precede short filename directory entries. The characters comprising the filename are Unicode characters requiring 2 bytes each.

directory entry. The eight-character filename and three-character extension occupy the first 11 bytes. These fields contain 8-bit ASCII character codes. Names shorter than eight characters in length and extensions shorter than three are padded with space characters (ASCII 32). The next byte holds a series of bit flags specifying the file attributes. The last 10 bytes of the directory entry store values indicating the time and date the file was created

directory entries to hold more than 11 characters. If a new operating system used a new directory entry format, you wouldn't be able to copy a file to a floppy disk with the new system and then read it with the old one. Another problem is that if this new operating system returned 255-character filenames, many older applications, which expect to receive no more than 11 characters, would crash. Why? Because a program has to set aside memory to store the filenames it reads, and if it sets aside 16 bytes for a filename and the operating system copies, say, 32 characters into that space, then other data gets overwritten. Any programmer can tell you that the surest way to break an application is to copy random data into its data space.

Windows 95's designers devised a clever solution to the problem of supporting long filenames while preserving compatibility with previous versions of DOS and Windows applications. When most applications (except for low-level disk utilities such as the Norton Disk Doctor) query the system for file and subdirectory names, they do so not by reading directory entries directly off the disk, but by using enumeration functions built into the operating system. Through testing, Microsoft found that if a directory entry is marked with an "impossible" combination of read-only, hidden, system, and volume label attribute bits—that is, if the directory entry's attribute byte holds the value 0Fh—the enumeration functions built into all existing versions of DOS and all pre-95 versions of Windows will skip over that directory entry as if it weren't there.

The solution for Windows 95, then, was to store two names for every file and subdirectory: a short name that's visible to all applications and a long name that's visible only to Windows 95 applications and to applications that have been rewritten to add support for long filenames. Short filenames are stored in 8.3 format in conventional 32-byte directory entries. Windows creates a short filename from a long one by truncating it to six uppercase characters and adding "~1" to the end of the base filename. If there's already another filename with the same first six characters, the number is incremented. The extension is kept the same, and any character that was illegal in earlier versions of Windows and DOS is replaced with an underscore.

Long filenames are stored in specially formatted 32-byte long filename (LFN) directory entries marked with attribute bytes set to 0Fh. For a given file or subdirectory, a group of one

or more LFN directory entries immediately precedes the single 8.3 directory entry on the disk. Each LFN directory entry contains up to 13 characters of the long filename, and the operating system strings together as many as needed to comprise an entire long filename.

Think about what this means. If a file with a long filename is copied to a floppy disk and that floppy disk is inserted in a PC running DOS or Windows 3.x, only the short filename

is visible to the operating system, which ignores the LFN directory entries. And because only the short filename is visible, an application that requests a file or subdirectory name from the operating system won't get surprised with a longer-than-expected name. Pretty slick.

Under Windows 95, 16-bit DOS and Windows applications still see only short filenames, because the operating system answers requests for file and subdirectory names with 8.3 names unless applications call special enumeration functions that are LFN-compatible. All 32-bit Windows applications call LFN enumeration functions by default, so they get access to long filenames right out of the box.

Figure 2 shows the format of the LFN directory entry. Filenames are stored in Unicode

The attribute field appears at the same location in LFN directory entries as in 8.3 directory entries. It has to, because the file system doesn't know which type of directory entry it's dealing with until after it examines the attribute byte. The starting cluster number field also appears at the same location, but in LFN directory entries its value is always 0. The type indicator field also holds 0 in every long filename I've examined, but Adrian

King's *Inside Windows 95* (Microsoft Press, 1994) says it can also hold a nonzero value indicating that the directory entry contains "class information" for the corresponding file. (Unfortunately, the book doesn't

say what class information is, so one can only guess what Microsoft had in mind there.) The LFN directory entry's checksum byte holds an eight-bit checksum value computed by adding certain fields of the 8.3 directory entry and performing a modulo 256 operation on the result. Windows 95 uses this checksum to detect orphaned or corrupted LFN directory entries.

An LFN directory entry is created even if a long filename is short enough to fit the 8.3 format, because long filenames preserve case and short filenames do not. Figure 3 shows a hex dump of the directory entries for a file named Budget.xls. The short name (BUDGET.XLS) is stored in the 8.3 directory entry. Immediately preceding that entry is an LFN directory entry containing the filename Budget.xls. The LFN directory entry's sequence number is 1, with bit 6 set to 1 to show it's the last entry as well as the first. Because LFN directory entries always come right before the corresponding 8.3 directory entries, Windows 95 can easily locate a long filename once it has found the 8.3 directory entry for a specified file or subdirectory.

Figure 4 illustrates what the short and long filename directory entries would look like if our file were named "Budget for Fiscal Year 1996.xls" instead of Budget.xls. Because the long filename now contains 31 characters, three LFN directory entries are required. Note the reverse order of the LFN directory entries: The first 13 characters of the long filename are stored in the LFN directory entry preceding the short filename, the next 13 in the entry before that, and the final five in the entry before that.

THE DARK SIDE OF LFNs

On the surface, VFAT's method of supporting long filenames while preserving compatibility with legacy applications seems an ideal solu-

```
41 42 00 75 00 64 00 67-00 65 00 0F 00 D8 74 00 AB.u.d.g.e....t.
2E 00 78 00 6C 00 73 00-00 00 00 00 FF FF FF FF ..x.l.s.....
42 55 44 47 45 54 20 20-58 4C 53 20 00 96 34 87 BUDGET XLS ..4.
70 20 70 20 00 00 54 48-70 20 C9 03 A9 1D 00 00 p p ..THp .....
```

FIGURE 3: This is a hex dump of the directory entries for a file named Budget.xls.

```
43 36 00 2E 00 78 00 6C-00 73 00 0F 00 E0 00 00 C6...x.l.s.....
FF FF FF FF FF FF FF FF-FF FF 00 00 FF FF FF FF .....
02 73 00 63 00 61 00 6C-00 20 00 0F 00 E0 59 00 .s.c.a.l. ....Y.
65 00 61 00 72 00 20 00-31 00 00 00 39 00 39 00 e.a.r. .1...9.9.
01 42 00 75 00 64 00 67-00 65 00 0F 00 E0 74 00 .B.u.d.g.e....t.
20 00 66 00 6F 00 72 00-20 00 00 00 46 00 69 00 .f.o.r. ...F.i.
42 55 44 47 45 54 7E 31-58 4C 53 20 00 4A CF 88 BUDGET~1XLS .J..
70 20 70 20 00 00 54 48-70 20 C9 03 A9 1D 00 00 p p ..THp .....
```

FIGURE 4: This is a hex dump of the directory entries for a file named "Budget for Fiscal Year 1996.xls."

format, which requires 2 bytes per character as opposed to ASCII's 1 byte. Filename characters are spread among three separate fields: the first 10 bytes (five characters) in length, the second 12 bytes (six characters), and the third 4 bytes (two characters). The lowest five bits of the directory entry's first byte hold a *sequence number* that identifies the directory entry's position relative to other LFN directory entries associated with the same file. If a long filename requires three LFN directory entries, for example, the sequence number of the first will be 1, that of the second will be 2, and the sequence number of the third will be 3. Bit 6 of the third entry's first byte is set to 1 to indicate that it's the last entry in the sequence.

tion. And in many ways it is. But VFAT's LFN support is still far from perfect. Here's why.

One of the problems with long filenames is that they consume more disk space than short ones. That's not a big deal when long names are stored in subdirectories, because as long as disk space is available, subdirectories can grow to accommodate added directory entries. But the maximum number of directory entries available in the root directory is fixed, and long filenames eat up space in the root directory as if there's no tomorrow. The root directories of most hard disks contain at most 512 directory entries. Because a 128-character name requires 11 entries (ten for the long name and one for the short name), you could create only 46 files and subdirectories in the root directory if each were given a 128-character name. Using long filenames in the root

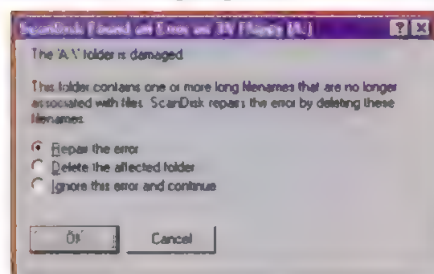


FIGURE 5: ScanDisk detects orphaned LFN directory entries and gives you a chance to delete them using the dialog box shown here.

directories of drives formatted with more advanced file systems such as OS/2's HPFS and Windows NT's NTFS isn't a problem, because the sizes of their root directories aren't fixed.

A more serious problem arises when LFN directory entries become orphaned. Let's say you copy a file with a long filename to a floppy disk and give the disk to someone who runs DOS or Windows 3.1. If that person deletes or renames the file, the 8.3 directory entry gets deleted or renamed, but the LFN directory entries get left behind, because neither DOS nor Windows 3.1 knows anything about LFN directory entries. The LFN directory entries are said to be "orphaned." (Of course, you could orphan LFN directory entries on your hard disk, too, if you booted from a DOS floppy and proceeded to delete or rename files on your hard disk.)

Windows 95 recognizes that an orphaned directory entry is invalid, because its checksum no longer matches the 8.3 directory entry that follows it. But as far as I can tell, orphaned entries never go away. Unless you run ScanDisk on the disk, they just sit there, tying up disk space. ScanDisk detects orphaned LFN directory entries and asks you if you'd like them deleted (see Figure 5).

What about 16-bit applications running under Windows 95? Is it safe for them to delete or rename files? To its credit, Windows 95 recognizes when a legacy application that

isn't LFN-enabled deletes or renames a file. In both cases, it deletes the LFN directory entries to prevent them from being orphaned; thus, if a legacy application renames a file (using its short name), the long filename is lost. For this reason, it's a good idea to stay away from long filenames if you still use your favorite DOS or Windows 3.1 application to do file and directory management.

Even if you use nothing but 32-bit applications, there are still instances in which long filenames can use disk space inefficiently. As files are created and deleted within a directory, directory entries become "fragmented," in the sense that discarded entries become scattered among the valid ones. Since the LFN and 8.3 directory entries for a given file or subdirectory must reside in contiguous entries, it's possible for a directory to be mostly empty yet still not have room to store a new long filename. This is because there aren't enough contiguous free directory entries. So if the largest group of consecutive empty directory entries is three entries in size and you create a file whose name requires four, then either the creation will fail (if the file is being created in the root directory) or the system will allocate more disk space for four new directory entries (if the file is being added to a subdirectory).

Either way, disk space is wasted, because empty entries are unused. Worse, if a lone empty directory entry becomes trapped between used ones, the only way that entry will ever be used (assuming you don't delete the ones surrounding it) is if a legacy application creates a file or subdirectory that happens to use that particular directory entry (a file or subdirectory created by a legacy application requires only one directory entry, because the system does not create a long filename to go with it).

The only solution to this problem that I've found is to defragment the disk. Windows 95's Defrag utility packs directory entries together so that unused entries are consolidated into a pool. It's always a good idea to defragment your drives periodically, but it's even more important to do it regularly if you use long filenames.

FOREWARNED IS FOREARMED

Now that you understand how long filenames are implemented in Windows 95, you should find it easier to avoid the trouble spots. In general, you'll get the most out of long filenames if you primarily use 32-bit applications, run Defrag and ScanDisk regularly, and avoid the unnecessary use of long names in the root directory.

VFAT's long filename support may not be perfect, but it's still a huge improvement over the 8.3 filenames we were stuck with before. □

Jeff Proise is a contributing editor of PC Magazine.



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PC Tech/Internet Tools

By Luisa Simone

Creating Graphic Images for the Web

Whether .GIF or JPEG, it's all about pixels, color, and compression.

Even if you're a beginning World Wide Web publisher, you are sure to discover lots of good reasons to include various kinds of images in your online documents. On the most basic level, pictures give your Web pages more visual appeal. As you compete for readers' attention, images are often a good way to entice and encourage visits to your Web site.

Pictures can also serve an informational purpose. Remember that it is the *World Wide Web*. Diagrams, photographs, maps, and picture icons can help convey your message to international Web surfers who may not be fluent in English. Graphics can also serve as navigational links by including hot spots that, when clicked, function exactly like hypertext links moving a reader to another page within the current document, to another document on your Web site, or to another location altogether on the WWW.

You can even use pictures of text to overcome design limitations of Web publishing, specifically HTML codes. Desktop publishing formatting instructions control the appearance of text, but HTML (HyperText Markup Language) controls only the structure of a document. You can designate the hierarchical relationship between elements by designat-

ing which text string is a first-level headline and which paragraphs are body copy, but you can't specify typeface or point size. In fact, text formatting (such as typeface and point size) is controlled by the reader's browser program. As the publisher, you can guarantee that a particular type style will appear on your Web pages only by generating a picture of the text and inserting it into your HTML documents as a graphic.

All of the aforementioned uses require you to import pictures into your HTML documents as inline elements. Inline graphics appear within the main browser window and are embedded in the text flow. Currently, inline graphics are restricted to two file formats: the CompuServe Graphics Interchange Format (.GIF) and the Joint Photographics Expert Group format (JPEG).

Pictures in a wide range of graphics file formats also can be stored externally on your Web server. External graphics can be downloaded for off-line viewing or viewed online in a separate window with the assistance of a helper (or MIME) application.

.GIF AND JPEG: SIMILARITIES

There are both historical and technical differences between the .GIF and JPEG file formats. Before exploring the differences, however,

you should consider the similarities of these two standards. Both .GIF and JPEG are raster (also called bitmapped or paint) formats. They can represent a broad variety of image types, including drawings, pictures of text, paintings, and photographs. Both the .GIF and JPEG formats are cross-platform formats, which means that they can be viewed on PCs, Macs, or Unix systems. Finally, both formats are built around a compression scheme that can greatly reduce file size.

The last point is no trivial matter. Because they typically store color information about each pixel in a picture, raster images can grow quite large. Large graphics files can take a long time to download, especially if your readers are using slow dial-up lines and 14.4-Kbps modems. Your objective as a Web publisher will be to produce the smallest, most efficient graphics files without compromising image quality.

In general, you can use three techniques to reduce file size: Reduce the number of pixels in an image, reduce the number of colors in the image, and employ a compression scheme.

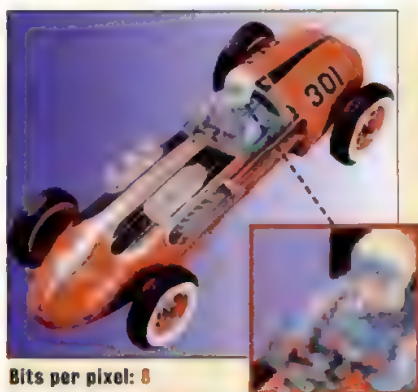
SIZING PICTURES APPROPRIATELY

When you publish on the Web, your output medium is not paper, but a monitor. Moni-

FIGURE 1: Reducing the number of colors in a picture can greatly reduce file size. But notice the enlargements, which show how image quality can be compromised as the number of colors drops.



Bits per pixel: 24
Number of colors: 16.7
million potential colors
File size: 95K



Bits per pixel: 8
Number of colors: 256
File size: 23K



Bits per pixel: 5
Number of colors: 32
File size: 13K

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tors are basically low-resolution devices, so you should produce small, low-resolution images. Measuring your pictures in pixels will help, because that is how the resolution of a monitor is measured. For example, a 200-by-200-pixel image will occupy nearly one-sixth of an average 640-by-480 VGA monitor. That's quite a lot of real estate to give up to a single picture. Although it won't work for every picture, try to create pictures that measure between 80 and 150 pixels vertically and horizontally. Iconic images destined to become clickable buttons should be even smaller.

When pictures get this small, you'll have to make some compromises concerning the content. Don't expect to reproduce small details, fine line drawings, or small objects photographed from great distances. Instead choose tightly cropped images with bold lines, bright colors, and solid (or evenly graduated) backgrounds, to keep objects recognizable even at tiny sizes (for an example, see Figure 1, which reproduces an antique toy car from MetaTools' Power Photos III clip-art collection).

REDUCING THE NUMBER OF COLORS

In a perfect computer world, all graphics files would be in glorious 24-bit color. But in the real world, you can greatly reduce file size (and conserve resources) by squeezing the full 16.7 million potential colors into 256 or fewer colors. Choosing to reduce the number of colors in a picture is in effect a decision to use the .GIF format. That's because .GIF supports a maximum of 256 colors, which are stored in a directory called, variously, the color palette, the color lookup table, or the color index.

Compare the three versions of the same picture in Figure 1. This series clearly demon-

strates the advantages of color reduction. By dropping the image from 24 bits per pixel to only 8 bits per pixel, you reduce the file size by three-quarters. Dropping the amount of data per pixel even further, to 5 bits, produces a file with only 32 colors at a size of only 13K.

If you look at the enlargements directly below each image, however, you'll see that fewer colors can translate into poorer image quality. Whenever you reduce a 24-bit full-color picture to 8-bit indexed color, you must choose conversion options carefully, in order to produce the closest possible match to the original image. Figure 2, which shows the Index Color options dialog box in Adobe Photoshop, outlines the three parameters that ultimately determine both the size of the file and the quality of the picture.

Resolution here refers to color resolution

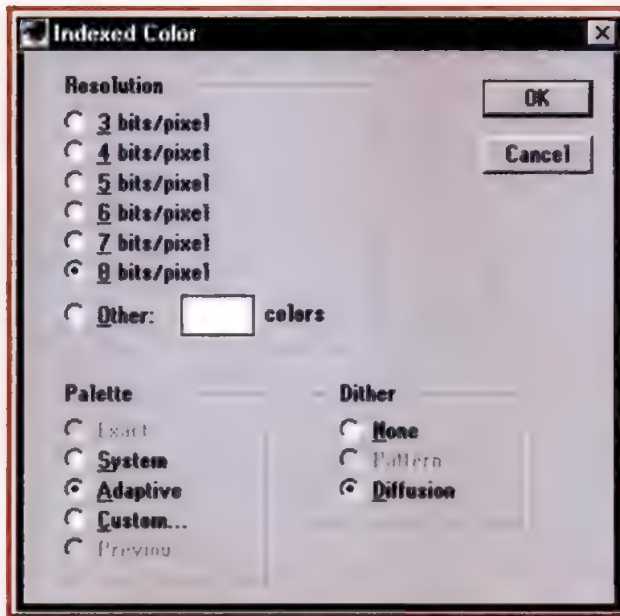


FIGURE 2: The Index Color options in Adobe Photoshop allow you to determine the number of colors, the type of palette, and the pattern of pixels in the target image.

or bit depth. The number of data bits per pixel yields the number of colors that will appear in the palette and subsequently in the picture. A bit depth of eight, for example, produces a 256-color palette. To compute the number of colors in any given palette, use the number of bits per pixel as the exponent for the number 2, where 2 represents the two states (on and off) for each bit. Thus, a resolution of four bits per pixel will produce a 16-color palette (2^4 or $2 \times 2 \times 2 \times 2$).

If you want the best shot at matching the colors in the original image, choose the palette type carefully. System or uniform palettes use predetermined colors that often bear little relationship to the colors in the picture. The best choice is usually the adaptive or optimized palette, which is based on a histogram it creates of the most frequently occurring colors in a picture.

One major word of warning about optimized or adaptive palettes. This setting creates a unique palette for each and every image. If, however, your HTML document contains multiple images and each one has a unique palette, you (or your readers) will encounter palette conflicts. Palette conflicts are common to Windows applications when indexed color images are displayed sequentially. They are especially common on older systems equipped with slow graphics adapters. Basically, Windows always loads the palette *before* it loads an indexed color image. So if you already have an image that uses a different palette on screen when the new palette is loaded, the current screen image will be remapped to the new palette—producing weird video flash. In order to avoid palette conflicts, you must produce a single optimized palette for all of the images in your HTML document. You'll find that standard image editing

ESSENTIAL OPTIONS FOR .GIF FILES

Vendor	Product name	List price	Optimized palette	Multiple files optimized to a single palette	Transparency	Transparent version of any color	Interlacing
Adobe Systems Inc. 800-833-6887	Adobe PhotoShop v3.0.5	\$895.00	✓		✓	✓	✓
Corel Corp. 800-772-6735	Corel PhotoPaint	\$289.00	✓		✓	✓	✓
Fractal Design Corp. 800-297-2665	Painter 4	\$549.00	✓		✓	✓	✓
Handmade Software Inc. 800-252-0101	Image Alchemy/386 v.1.8	\$199.95	✓	✓	✓	✓	✓
Micrografx Inc. 800-676-3110	Picture Publisher 6.0*	\$299.95	✓		✓	✓	✓
Quarterdeck 800-683-6696	HiJaak 95	\$59.95	✓		✓		✓
Ulead Systems Inc. 800-858-5323	PhotoImpact	\$199.00	✓		✓	✓	✓

* Picture Publisher 6.0 is a component of ABC Graphics Suite

programs (see the table "Essential Options for .GIF Files") don't make this easy. But dedicated graphics programs such as Handmade Software's Image Alchemy have automated the process and create a single optimized palette from a group of designated files.

Finally, when it comes to arranging pixels into patterns, dithering (sometimes referred to as *diffusion dither*) is preferable to either solid colors (the None option) or a regular pattern. Solid areas of color typically result in posterization, which is a fine Peter Max effect, if that's your intention. Patterning, especially at low screen resolutions, produces a noticeable checkerboard that can interfere with the image. The dithered option has two benefits. First, it allows the software program to intermingle pixels of two or more colors to create the illusion of a new color. Alternating yellow and blue pixels, for example, can produce an optical mixture of green. Dithering also helps soften the transition from one color to another and thus avoids obvious banding in graduated fills.

USE COMPRESSION METHODS

Graphics file formats incorporate compression/decompression algorithms as part of the file open/save or import/export operation. The .GIF and JPEG formats both use sophisticated compression algorithms, but they differ in that .GIF incorporates a lossless compression method and JPEG a lossy method.

.GIF files are built around the lossless Lempel-Ziv-Welch (LZW) compression scheme. Lossless compression preserves all of the visual data in a picture: No information is discarded or altered during the compression/decompression operation. The compression scheme looks for complex repeated patterns within an image. By notating these larger patterns, rather than storing RGB values for each and every pixel in an image, LZW compression yields significant, if not startling, file-size reductions. A 2:1 compression ratio (where a compressed file is approximately half the size of an uncompressed file) is not uncommon.

In contrast, JPEG is a lossy compression scheme. It achieves very high compression ratios by discarding data. As a result, when the compression ratio gets too high, image quality can be affected. Figure 3 compares three different images. With no compression, the first image logs in at a hefty 203K. Using the Medium setting in Photoshop preserves image quality *and* drops the file size down to only 12K, for a compression ratio of 17:1. The last image, which exhibits some blocky artifacts, requires only 9K of disk space. It was produced by converting the image in a dedicated graphics utility program (Inset Systems' HiJaak 95) at a quality setting of 90.

JPEG compression has another significant



FIGURE 3: JPEG, a lossy compression scheme, achieves very high compression ratios by discarding data. Notice, however, that the image quality does suffer. In the figures below, you can see how the image becomes blocky at higher compression ratios.

Compression setting: None
File size: 203K



Compression setting: Medium
File size: 12K



Compression setting: 90
File size: 9K

disadvantage. Although high compression ratios do result in smaller files and smaller files download more quickly, compressed data takes longer to decompress before it can be displayed on screen. In most cases, the lengthy decompression process cancels any time savings achieved from faster downloads.

MAKE DOWNLOADING SEEM FASTER

You can tweak your graphics files to make it seem as if the images are downloading faster than normal. The .GIF format, in particular,

supports a feature called interlacing, which basically keeps track of the odd-numbered and even-numbered scan lines in a picture separately. At download time all of the odd-numbered scan lines are transmitted first. The result, from the end user's point of view, is that the "full" image appears on screen in half the time. That's because the image consists of only half the data (every other scan line): Although it appears faster, it is also blurry. The image will come into focus as the second half (the even-numbered scan lines) of the data is downloaded. In truth, interlac-

ing doesn't shorten the actual time it takes to download the entire .GIF file. But because the "entire"—albeit blurry—image is displayed, the psychological effect is the same as speeding up transmission.

Until very recently, only .GIF files offered the benefits of interlacing. A new flavor of the JPEG format, however, called progressive JPEG (or PJPEG), produces the same result. The format is so new though that you won't find many programs supporting it. Currently, Ulead Systems' PhotoImpact is the only program on the market that can write progressive JPEG files. By the time you read this article, however, a Photoshop plug-in (also available as a standalone program) called Transmogrifier, from InTouch Technologies (617-332-6800; \$22.00 for the full-featured plug-in, \$12.00 for a streamlined standalone version), should be available for Windows. Until then you'll have to wait for upgrades to your favorite image editing program and for other Mac-based utilities to migrate to the PC. Rumor has it that a Windows version of the popular Mac-based file conversion program DeBabelizer, from Equilibrium Technologies (<http://www.equilibrium.com>), is under development.

An even simpler way to increase the apparent speed at which images appear in your HTML documents is to use an image more than once. Web browsers cache images after downloading them. When an image is already stored on the local hard disk, it is displayed faster on subsequent pages. This is an ideal technique for a company logo, which can (and probably should) appear on every page of your document.

You can also repeat a picture to good advantage by using it as a background pattern or wallpaper motif. You will need to work with

the HTML 3.0 specification, but given that requirement, wallpaper is rather easy to implement. You simply designate a graphic file as part of the BODY BACKGROUND HTML tag. Provided that the picture is smaller than the browser's window, the image is automatically tiled. This technique works best when done subtly. The graphic should appear as a lightly tinted watermark, so that it doesn't interfere with the legibility of the text on your page.

.GIF OR JPEG?

Now that you have all this information about JPEG and .GIF formats, the question remains: Which format do you choose for your HTML documents?

If you're looking for absolute compatibility with the broadest range of browsers on the Web, choose the .GIF format. There isn't

a graphical browser that doesn't support it. .GIF also offers one feature not found in the JPEG format: transparency. This may sound like a frivolous feature, but it allows you to create silhouettes against the background color of the HTML page. Using silhouettes addresses another limitation of HTML formatting. Just as with font choice, you (as the publisher) can't control the color of the HTML page; the end user's browser does that. Because you can't anticipate the color of the background in a reader's browser, you can't simply recolor the background of your picture to match it. Instead, you must make the background of your graphic transparent.

Figure 4 shows the transparency options in the Photoshop 3.0.5 .GIF 89a export dialog box. Notice that you can make more than one color transparent, and you can select the color either from the palette or directly from the image.

JPEG should be your file format of choice if you are working with photographic images with lots of subtle color and tonal information. Because you don't have to reduce 24-bit color down to only 8 bits of data (or 256 colors), you have a much better shot at faithfully reproducing images in JPEG.

No matter which of the two formats you decide to use, the techniques discussed here will help you create efficient graphics for your Web site that will enchant the sensibilities of your readers without making unrealistic demands on their system resources. □

Luisa Simone is a contributing editor of PC Magazine. She is the author of Microsoft Publisher by Design, now in its third edition. Her book The Windows95 Scanning Book (John Wiley and Sons) contains more information on creating and manipulating raster graphics.

New Graphics Formats for Navigator 2.0

While JPEG and .GIF are the de facto standards for viewing graphics online, new technology that will enable you to view many different graphics formats has already arrived on the scene in the form of plug-in additions to Netscape Navigator 2.0. Netscape, of course, is only one of the many different browser applications that you may use to peruse your documents. But if you're confident that your readers will be using Netscape, you can incorporate a wide variety of graphics formats into your HTML documents.

Using plug-in technology, you can incorporate vector formats into your documents, such as the CGM format (using InterCAP's MetaLink RunTime CGM), AutoCAD's DWG/DXF format (Soft-Source's DWG/DXF), or Corel Draw's CMX format (Corel Corp.'s

CMX Viewer). Several plug-in products support a variety of formats. For example, Carberry Technology's FIGLeaf Inline allows Navigator to display .CGM, .PNG, .TIFF, .BMP, .WMF, and .EPSF files.

Plug-ins also provide access to cutting-edge graphics formats that provide higher compression ratios and better image quality for raster images. For example, Fractal Viewer reads the highly compressed and resolution-independent raster fractal format developed by Iterated Systems. And two products, Wavelet Image Viewer by Summus and Lightning Strike by Infinet Op, let Navigator users view wavelet-based images online.

For more information on any of these products, check out Netscape's Web page at <http://www.netscape.com>.

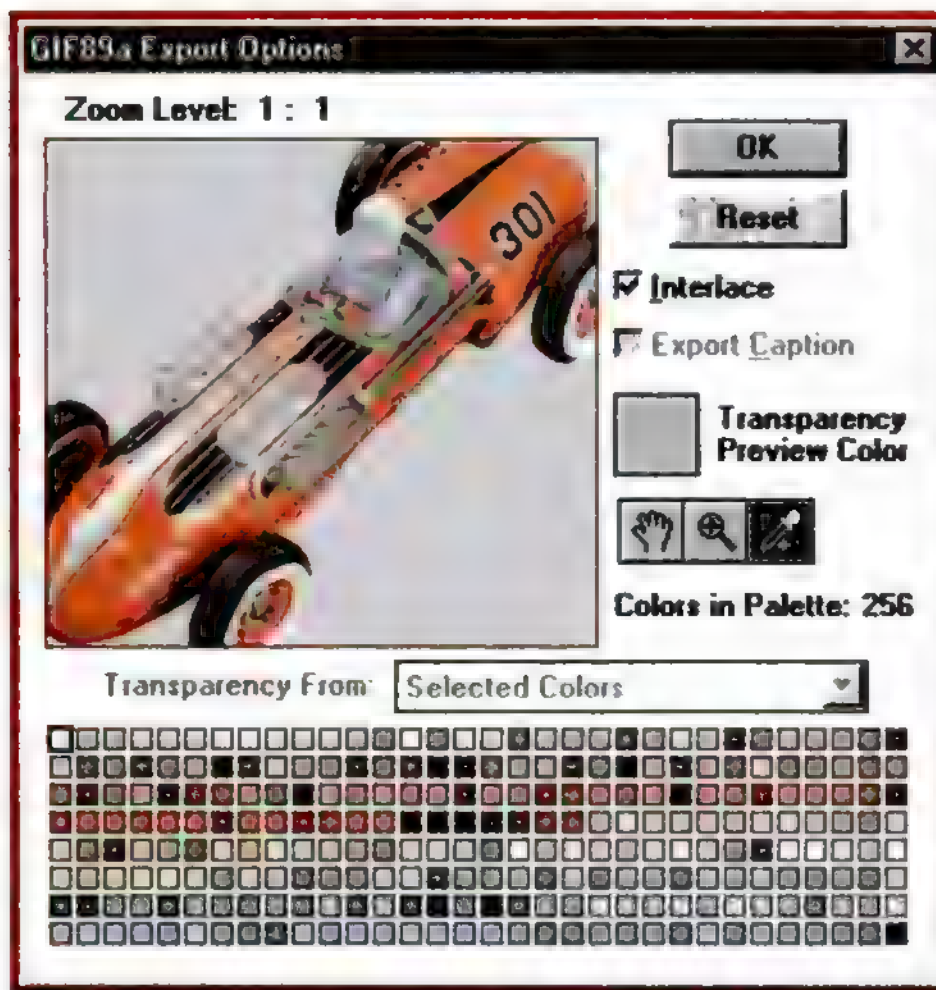


FIGURE 4: Transparency options in the Photoshop 3.0.5 .GIF 89a export dialog box.

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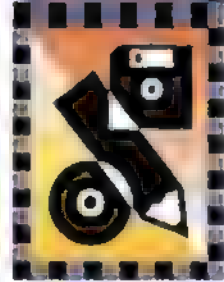
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PC Tech/Lab Notes

By Mark L. Van Name and Bill Catchings

The New Standard in 32-Bit Windows Testing

Winstone 32 measures performance on the new generation of 32-bit code.

The Windows market today is in transition, moving from 16-bit to 32-bit applications. The 16-bit packages that dominated a year ago are still in wide use with Microsoft Windows 3.1x and many Windows 95 systems. But most new releases are 32-bit programs designed to run natively on Windows 95 and Windows NT. With this issue's PC reviews, PC Magazine Labs introduces Ziff-Davis's Winstone 32, a 32-bit benchmark test program designed to measure a PC's performance when running this new generation of 32-bit Windows applications.

Winstone 32 is a 32-bit sibling of ZD's Winstone 96, the industry standard for measuring the performance of systems running 16-bit Windows applications. Both benchmark test programs also take the same basic approach: They use scripts that exercise real applications to produce measures of a PC's overall performance.

The key area in which the two test suites differ is in the applications their tests employ. Winstone 32 uses leading 32-bit Windows apps to put PCs through their paces; Winstone 96 measures system performance using leading 16-bit applications only.

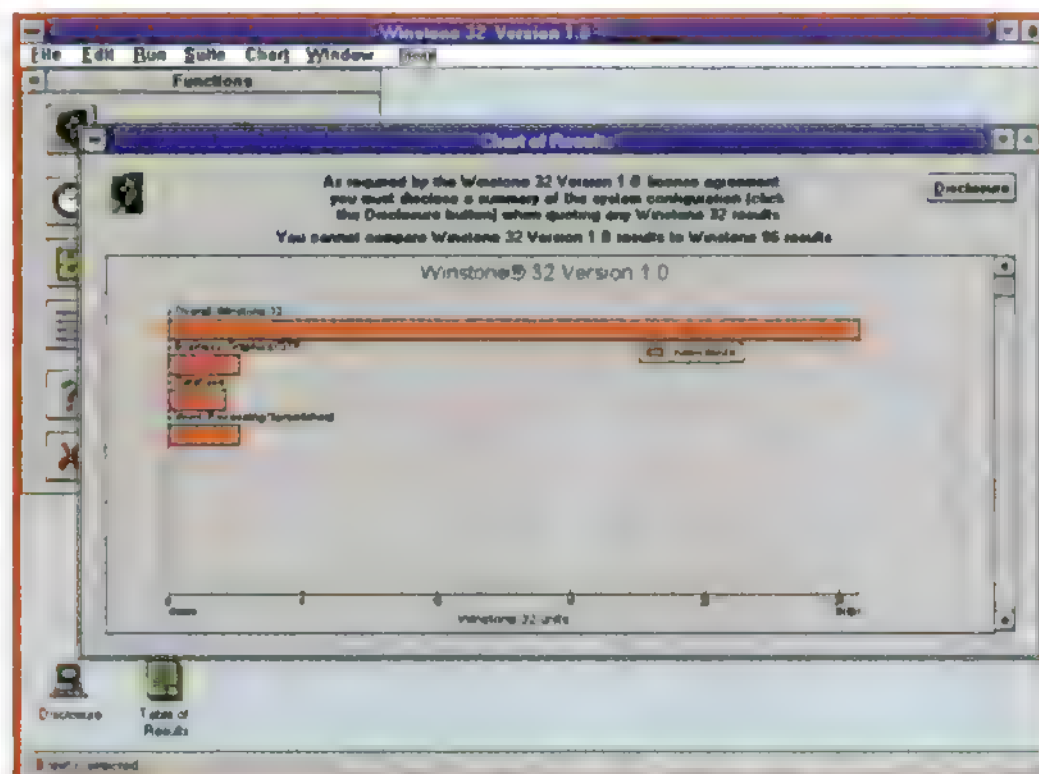
The different purposes and application sets of the two Winstone versions gives them different operating-system requirements. Winstone 32 targets the platforms hosting today's and tomorrow's 32-bit apps, Windows 95 and Windows NT. Winstone 96 concentrates on the leading Windows platforms for 16-bit applications, Windows 95 and Windows 3.x. Together, the two benchmark test programs give *PC Magazine* an unmatched ability to gauge overall PC performance.

GUIDING PRINCIPLES

Winstone 32 shares with Winstone 96 a few key underlying principles. Both are market-centered benchmark test programs that aim to measure the performance typical PC users will see while conducting common operations with leading business applications. The scores they produce will be useful to the vast major-

ity of us, because most users spend a great deal of computing time working with the same basic classes of applications.

Not everyone, of course, fits this profile. If all you do with your computer is run circuit-simulation packages, Winstone 32's scores won't be as meaningful for you as for typical business application users. Fortunately, another ZD benchmark test program, WinBench 96, contains hundreds of tests that gauge the performance of just about every aspect of every major PC subsystem. With it, you can focus on precisely those PC subsystems that most affect your work.



Winstone 32 provides both an overall performance score and scores in three application categories: Business Graphics and Desktop Publishing, Database, and Word Processing and Spreadsheet.

Winstone 32, like Winstone 96, is application-based. It runs real applications (not special crippled or demo versions) through a series of scripted activities. We have selected those activities by looking at extensive surveys of the way users work with leading business applications. Each score produced by Winstone 32 reflects the time a PC needs to complete those activities.

SETTING UP TO TEST

Like other ZD benchmark test suites, the complete Winstone 32 product—exactly the same software we use in our tests—is available to the public free of charge. Winstone 32 is included in the newest release of the Ziff-Davis

PC Benchmarks CD-ROM, which also contains our Winstone 96 and WinBench 96 test suites (see the sidebar "How to Get Copies of Winstone 32"). Over the past few years, we've distributed millions of copies of ZD benchmark tests, and organizations of every size use them today as purchasing standards. Winstone 32 brings you the additional ability to zero in on 32-bit Windows application performance.

If you've worked with either Winstone 96 or WinBench 96, you will feel at home with Winstone 32. It shares the same simple installation process and interface as those benchmark tests. Installation is a matter of clicking a few buttons. Once you launch the benchmark test program and acknowledge the license agreement (first time only), you can produce system scores with just a click of the large Run button.

You do need to set aside some disk space, however. A full Winstone 32 installation requires 70MB of disk space for the applications and test code, plus an additional 30MB for the working directory in which Winstone 32 will run its tests. If you're short on disk space, you can also run Winstone 32 directly from the PC Benchmarks CD-ROM or from a server. In either of those cases, the only local storage Winstone 32 requires is the space for its working directory plus executables and relevant files.

Windows 95 and Windows NT are clearly different computing environments, and you should test under the OS you plan to use. If you're testing on Windows NT 3.51, Winstone 32 requires that you have NT's Service Pack 1 or later installed. (You can download the latest Windows NT service packs from <http://www.microsoft.com>.)

The PC Benchmarks CD-ROM includes an extensive reference manual covering all the details of running the product. It also has online help files and a short testers' handbook with all the facts you need to start a test run.

OBTAINING MEANINGFUL RESULTS

The hard part about testing is making sure you achieve accurate, repeatable results and

that you use those results to make meaningful performance comparisons. Both the test procedures and the system configuration options, such as the amount of installed RAM, will unavoidably affect your results. That's fair, because those same factors will also affect your PC's real-world performance.

When we test PCs with Winstone 32, we employ a set of basic standard testing procedures, outlined in Winstone 32's documentation. If you follow these procedures, your test results will be both accurate and repeatable: Winstone 32's scores will not vary by more than about 3 percent across multiple runs on the same PC (in the same configuration and running the same operating system, of course).

If you do nothing else, you should try to defragment the PC's disk and reboot the system each time before you run Winstone 32. You should also make sure no other applications are active while Winstone 32 is running. Otherwise, the system resources that any active applications consume will affect the PC's Winstone 32 performance, as it would affect the performance of running applications under the same conditions.

Proper test procedure is only half of good benchmark test use; the other half is context. Winstone 32 results are meaningful only in comparison with other Winstone 32 results. It does you no good, for example, to know that system X produced a Winstone 32 score of 60 without the Winstone 32 scores of other PCs for comparison. The critical importance of context is one reason our reviews always provide multiple results and a great deal of con-

How to Get Copies of Winstone 32

If you would like a copy of the CD-ROM that contains Winstone 32, as well as the 16-bit benchmark test suites Winstone 96 and WinBench 96, send a postcard to: Ziff-Davis Benchmark Operation
1001 Aviation Pkwy., #400
Morrisville, NC 27560
Attn.: Distribution coordinator
You can also fax your request to 919-380-2879. With all requests, please include

your name, address, and phone number, and note that you want the PC Benchmarks CD-ROM containing Winstone 32. Please allow four to six weeks for delivery. If you'd like faster delivery, enclose your Federal Express account number and Federal Express shipping instructions. The CD-ROM includes online copies of the manuals for Winstone 32 and the other PC benchmark test suites.

stone 32 results should provide similar types of configuration information. In fact, Winstone 32's license agreement requires them to do just that. If you're using Winstone 32 to help make buying decisions or recommendations from among a group of systems, it's important to hold all the configuration variables constant (CPU type, amount of RAM, and so on) or to recognize the importance of the variables you change.

INSIDE WINSTONE 32

To determine which applications to use in Winstone 32, we consulted with Computer Intelligence/InfoCorp (CII), a leading market research company (and another division of our parent company). We chose the 32-bit business applications with the largest current and projected unit market shares. The result was the following set of eight applications in three categories:

- **Business Graphics and Desktop Publishing:** Adobe PageMaker 6.0, Corel Systems' Corel-Draw 6.0, and Microsoft PowerPoint 7.0.
- **Database:** Borland International's Paradox 7.0 and Microsoft Access 7.0.
- **Word Processing and Spreadsheet:** Lotus Development Corp.'s Word Pro 96, Microsoft Excel 7.0, and Microsoft Word 7.0.

Those familiar with Winstone 96 will recall that it contains separate Word Processing and Spreadsheet categories. Winstone 32 combines these two into a single category, because few of the leading word processing and spreadsheet applications were available in 32-bit versions when we completed developing the benchmark tests.

When you press Winstone 32's Run button, the test program starts its tests. It measures a PC's performance by exercising each of these eight applications in turn, using an appropriate test script for each. The scripts, which ZDBOp developed using Microsoft Visual Test 4.0, take each application through a series of tasks that reflect extensive surveys of typical user application activity.

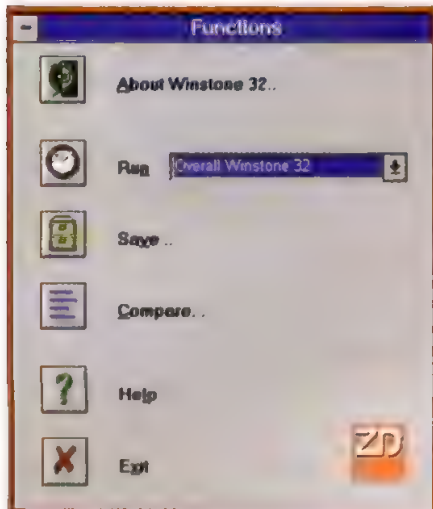
To produce its score, Winstone 32 first times how long the PC takes to complete each script. It then normalizes the unit's times

against the time that a base machine—a Dell PC with a 25-MHz 486SX CPU and 8MB of RAM, running Windows 95—took to complete the same script. Winstone 32 uses the normalized scores and the unit market-share weight of each application in a category to calculate a weighted harmonic mean, the score for that category. Then the test program takes the category scores and the unit market-share weights of the three categories to calculate another weighted harmonic mean, the overall score. Finally, Winstone 32 converts the overall score to a number relative to the overall score of the base machine, which by definition we set to 10.0. Winstone 32 also scales the three category scores against a score of 1.0 for the same base machine. We chose the different scaling factors so you could easily tell overall scores from category scores.

Higher Winstone 32 scores represent better performance. For example, a machine with an overall score of 20.0 is twice as fast on these leading 32-bit business applications as the base machine. Note that both Winstone 32's overall score and its category scores measure the performance of a PC as a whole system. If you want to focus on the performance of any one subsystem, such as the graphics or disk subsystems, use the appropriate tests from WinBench 96.

We mentioned earlier that you can run Winstone 32 from a server, from the PC Benchmarks CD-ROM, or from your hard disk once you've installed it there. No matter how you run it, though, Winstone 32 goes through the same testing process. First, it copies the files each application needs to run to a working directory, which should be on a hard disk of the PC you're testing. It then runs its test script for each application from that directory. Winstone 32's internal timing mechanisms ensure that all three methods produce the same result on a given PC with a given configuration and operating system.

Winstone 32's minimum RAM requirements depend on the operating system you're using. With Windows 95, Winstone 32 requires at least 8MB of system RAM to execute. With Windows NT, the minimum is 12MB of RAM. These are definitely minimum

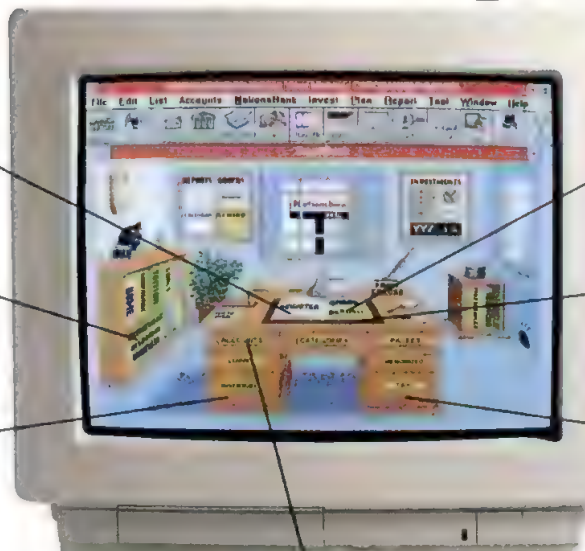


Winstone 32 uses the same simple interface as our existing 16-bit Winstone 96 and WinBench 96 benchmark test suites.

figuration information about the PCs and peripherals we test. This data lets you make apples-to-apples comparisons and provides a clear picture of the ranges of results that different types of PCs can produce.

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Winstone 32

Winstone 32, based on eight leading 32-bit Windows applications, lets you measure the performance of a PC running 32-bit software.

- Winstone 32 is our first desktop benchmark test suite for systems running Windows NT.
- Winstone 32 runs on Windows 95 and Windows NT 3.51 (or later) with Service Pack 1 (or later). Because Winstone 32's 32-bit applications use the 32-bit Windows API, Winstone 32 will not run under Windows 3.1 or OS/2.
- Winstone 32 provides both an overall system performance score and scores for

performance in three application categories: Business Graphics and Desktop Publishing, Database, and Word Processing and Spreadsheet.

- Winstone 32's application mix is based on new market-share data for 1995 and projections for 1996.
- Winstone 32 uses the same interface as Winstone 96, so it's easy to start testing right away.
- By using both versions of Winstone, available free on a single CD, you can test a PC's performance running 32-bit applications (using Winstone 32) as well as 16-bit applications (using Winstone 96).

amounts, however, which is why we typically test PCs with more RAM.

WINSTONE 32 AND 96: NOT COMPARABLE

Winstone 32 and Winstone 96 are similar enough in design that it may be tempting to try to run both benchmark test programs on the same PC and compare the results. Or you may want to compare the Winstone 32 scores of one PC with the Winstone 96 scores of

another. Resist this temptation. You cannot meaningfully compare the results of the two Winstone products. Several significant differences between the benchmark test programs make such comparisons invalid.

For one, while the two kinds of scores are calculated with reference to the same physical machine, their results are derived from two different operating systems. For Winstone 32, the base machine was running Windows 95,

while for Winstone 96 it was running Windows 3.1. This difference is very important, because these two operating systems place different demands on the machine.

In addition, Winstone 32 runs a completely different set of applications from Winstone 96. Even though some of the applications in both benchmark test programs share the same publisher and product name, the applications themselves are quite different from each other. Different applications means different weights: Winstone 32's weightings obviously reflect the market shares of the apps it uses, while Winstone 96's weights involve its set of applications. But you can certainly use Winstone 32 to gauge a PC's 32-bit Windows performance and use Winstone 96 to measure the same PC's 16-bit Windows performance.

As the industry continues its migration to 32-bit applications, so too will our benchmark tests. At the Fall Comdex, we'll introduce Winstone 97 and WinBench 97, both 32-bit benchmark test programs. We plan to discuss these new releases in a future issue. □

Mark L. Van Name is the vice president of product testing for Ziff-Davis Publishing Co. Bill Catchings is the director of the Ziff-Davis Benchmark Operation, the research and development division of Ziff-Davis that produces the company's benchmark tests.



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PC Tech/Utilities

By Michael J. Mefford

Quod: A New Classic Game for Your PC

Match your wits against the PC in this new strategic puzzle.

Classic games like chess, checkers, and backgammon share a common characteristic: The rules are simple, but playing well requires sophisticated strategy. Quod, a game invented by G. Keith Still, a British mathematician, shares this characteristic. The goal of the game is to place pieces on a grid so that they make a square. The player who makes a square first wins. Squares can be any size and orientation, and players have a limited supply of blocking pieces, which adds to the complexity and interest.

I first saw Quod described in *Scientific American* ("Mathematical Recreations," March 1996). Intrigued by the game, I contacted Mr. Still and, with his permission and encouragement, created a computer version of Quod. His help and advice on strategy were invaluable.

You can obtain Quod by downloading it from PC Magazine Online or by mail. (Refer to the sidebar "Guide to Our Utilities" for details.) The source code for Quod, which was written in Borland's visual programming tool Delphi, is also provided for those interested in seeing how it works.

THE RULES OF QUOD

Quod is played on an 11-by-11 square grid board with the four outer corners missing. (I'll explain the mystery of the missing corners in a bit.) Players take turns placing pieces on the board. Each player begins the game with 20 attacking (colored) pieces and 6 blocking (white) pieces. The object of the game is to outmaneuver your opponent and be the first to outline a square, called a *quod*, by playing all four corners with your colored attacking pieces. You use the blocking pieces to block your opponent's squares; they don't count toward making a square of your own.

On each turn, you place one attacking piece on the board. Optionally, before placing the attacking piece, you can place any number of blocking pieces, up to the six allotted. If both players run out of attacking pieces before either has made a quod, the player with the most unplayed blocking pieces is declared the winner. If each has the same amount of blocking pieces (or if neither has any), the game is declared a draw.

A winning square can be any size and ori-

entation. There are many possibilities (see Figure 1), and this is why playing Quod well requires strategy. Some fundamental winning strategies are discussed below. While playing Quod, you can obtain information on rules, strategies, and program operation by pressing the Help button.

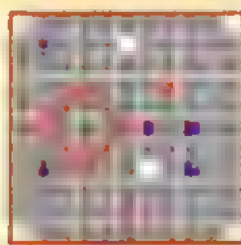
PLAYING QUOD

To install the Quod program, copy the files QUOD.EXE and QUOD.HLP to a subdirectory on your hard disk and create an icon for Quod in your shell. Quod is a 16-bit Windows program and will run under Windows 3.1, Windows 95, and Windows NT.

IN THIS ISSUE

Quod

Quod, a game invented by G. Keith Still, has simple rules, but playing well requires sophisticated strategy.



When you launch Quod, you'll see a picture of a Quod board set up for a new game, with program controls along the right edge (see Figure 2). Each player's pieces are stacked on the left edge. You can play Quod in the standard way, one player against another, or test your skills by playing against the computer. Under the label "Against:" you'll see two buttons. Click on the button with a picture of a computer to play against the computer; click on the button with a picture of a person to play against a human opponent. If you choose the computer as your opponent, you get the red pieces and go first, and the computer gets blue.

To place an attacking piece, left-click on the vacant circle where you want to put the piece. To play a blocking piece, right-click on the destination position. You can play blocking pieces only at the start of your turn—before you play your attacking piece. When you or your opponent make a square, the computer

automatically draws lines connecting the four corners and announces the winner.

Quod keeps a record over sessions of the number of wins for both red and blue. You can reset this record to zero by clicking the Clear button. When you play the computer, the computer helps you see the play it's about to make by "blinking" its piece onto the board. You can control the rate of blinking with the computer play speed scroll bar at the bottom of the program options panel. Click the "Reset speed" button to return the blinking rate to its default of three-quarters of a second.

The computer play speed control also varies the time lapse between when a winning quod is outlined and the winner notification dialog box appears. This delay is twice the blink rate. You can quit Quod by either clicking the Quit button or pressing Esc.

WINNING STRATEGIES

Every piece you play should have a strategic purpose—either to attack or to block. An attacking move is any move that helps to build a square in your own color. A blocking move is any move that prevents your opponent from building a square. Because of the many possibilities, it's easy to miss potential squares. You'll probably catch yourself cocking your head sideways in an attempt to find them all.

Once you have played your attacking piece, your move is over, so be careful to check your position and your opponent's possible squares before playing. This is obvious but bears repeating, because oversights are so deadly and so easy to make.

Don't use "psychological" strategies like hoping your opponent won't notice a potential quod, even if you're running out of blocking pieces. This is risky at best against a human opponent and hopeless against the computer, since the computer never misses a winning square. Always block your opponent's potential squares with either a blocking piece or an attacking piece.

At the beginning of the game there are no quods to make or to block, so you must base your play decisions on future potential squares. The center point is always a good first move, since from there you can make squares in all directions. Once the game gets going, try

to stay on the attack. When you're not forced to make a defensive move, always play offensively by creating potential squares. If you can't make the third corner of a potential square, make the second corner. Don't waste a turn by making a dead play, placing an attacking piece where it has no possibility of making a square.

Even if you have to make a defensive move, you can stay on the attack. If you have to block your opponent from making a square on his or her next turn, play an attacking piece instead of wasting a blocking piece if the blocking corner also can make a potential square for you.

You can also use your blocking pieces to move from defensive plays to offensive plays. If you're forced to prevent your opponent from making a square, but playing an attacking piece on the corner does not make a potential square for you, look around and see if you can make a square elsewhere on the board. If you can, block your opponent with a blocking piece and follow by playing the attacking piece where you can potentially make a square.

Since you only have a limited number of blocking pieces, your block and attack strategy has to be carefully timed so you don't run out of blocking pieces later in the game when you might desperately need them. In general it's best not to play blocking pieces too early in the game. Wait until the fourth or fifth turn, when you can better see your opponent's strategy and establish your own.

Of course, you are forced into playing a blocking piece if your opponent has cleverly created two (or more) potential squares in one turn. After you block the first, you can prevent the second with either another blocking piece or with an attacking piece. You must weigh the strength of your own potential attack, the number of blocking pieces you have left, and the number of blocking pieces your opponent has left when deciding whether to use another precious blocking piece.

When possible, create two potential squares simultaneously with one piece (a "double square" move). This forces your opponent to make two blocking moves on his or her turn. By playing a lot of double square moves early in the game, you can force your opponent to use up his or her blocking pieces.

The "shooting star" pattern shown in Figure 3 is the best method for making double squares and is a very strong play. Conversely, if you see that your opponent is attempting to

make a shooting star, block the pattern early before too much damage is done to your ration of blocking pieces.

QUOD PIVOT POINTS

When considering where to place an attacking piece on the board, think of all available

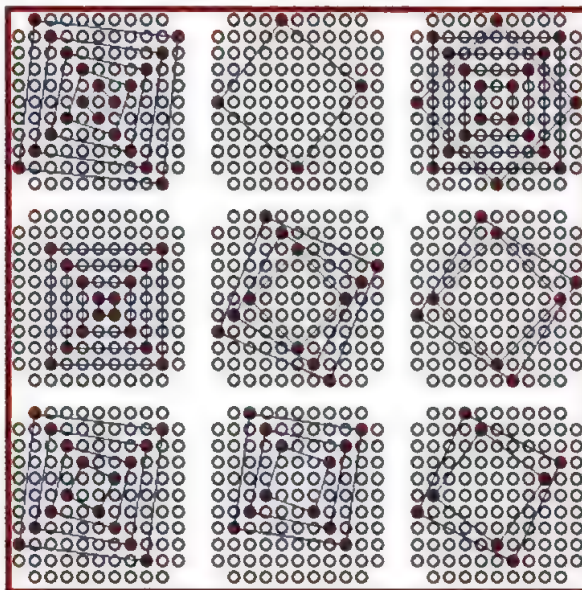


FIGURE 1: A winning square can be any size and orientation. These diagrams show the many possibilities.

playing positions as pivot points from which squares can be swung around. Start with the smallest square, the 2 by 2, and mentally rotate the square around the pivot point to its four possible positions. As an example, let's start with the center position as the first pivot point. Figure 4 shows the four possible positions for this square.

If you think of each position on the board as a pivot point, you can score the value of any position using a simple system (simple conceptually, but the number of calculations is very large). Look at each of the four squares in turn. If your opponent owns any point of a square, add 0 to the value of that pivot point, since you will not be able to complete the square. If your opponent owns none of the four corners, add 1 to the value of that pivot point, as it is possible for you to complete the square. If you already own any of the other corners, increase the pivot's point value by 1 for each additional corner owned.

Next, increase the imaginary square to the next possible size and swing it around again.

Add to the pivot's point value using the same rules you used for the smaller square. When you're done, increase the size of the square again and repeat the calculations. Continue doing this until the size of the square puts it over the edge of the board. In this manner you can give a pivot point a play value according to the total number of squares it can be a part of and how many corners are already made for each possible square. If you do the same for every position on the board, you can find the position with the greatest value and thus the best play.

Now, of course, this would be a monumental task to do in one's head. It would even be difficult and time-consuming to do on paper. But you don't actually have to total up pivot-point values to get a feel for which position is the better play. You'll find that once you train your eye to look at the board in this manner, you will be able to find good playing positions by simply eliminating those with many blocked positions. You can also evaluate your opponent's positions in this way.

A computer, of course, could do these pivot-point calculations almost instantaneously. You'll be glad to know I didn't add such logic, however. Doing so would have made the computer opponent all but invincible, ruining the fun of the game.

If you do pivot-point evaluations on a blank board, you will see that the center position has the highest possible value since it can swing out the farthest, thus making the most squares before going off the board. Or does it? You've just solved the mystery of why the outer four corners positions are missing from the playing board. After many hours of study, Quod's inventor realized that the first player would have an unfair advantage by playing the center position. But with the outer four corners of the board removed, the value of that center position is reduced so that the second

player had an equal chance. There was also an added bonus: Removing the corners made human players think more in terms of diagonals.

QUOD INNARDS

I didn't want the computer to play perfectly, since that wouldn't make it much of a game. But I did want to make it play very well. So instead of scoring each position

with the pivot technique described above, I created a series of prioritized decision-making steps.

The decision hierarchy, composed of nine prioritized strategies, is encoded in a

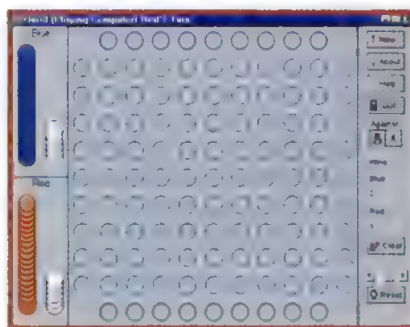


FIGURE 2: When you launch Quod, you'll see a picture of a Quod board set up for a new game, with program controls along the right edge and player pieces along the left.

procedure called Computer:

```
procedure TMainForm.Computer;
begin
  TimerCount:= 0;
  if FirstTurn then exit;
  if BlueWinningMove then exit;
  BuildRedMoves;
  BuildBlueMoves;
  if BlockOffensively then exit;
  if ((Turns > PreemptMoves)
    or (RedMovesCnt > 1))
    and (BlockWithBlocker) then exit;
  if BlockWithAttacker then exit;
  if BlueAttack then exit;
  if BlockPotential then exit;
  if StartPotential then exit;
  Move;
end;
```

Computer looks at each strategy in turn and sees if it can find a play that meets the criteria for that strategy.

Computer relies on two important data structures in making its decisions: an array called RedWinningMoves and another array called BlueMoves. (Remember that the computer always plays Blue.) The RedWinningMoves array stores all the moves by Red that will make the fourth corner of a winning square, or quod. Computer needs to know this to play effectively, because it needs to block any such moves. BlueMoves stores "almost winning moves"—moves in which Computer can place the third corner of a quod. Blue's winning moves aren't stored, because if Computer detects an opportunity to make a quod, it does so immediately.

The RedWinningMoves and BlueMoves arrays are crucial to Computer's decision-making. The functions to build these arrays are called only if strategy is necessary—if it's not the computer's first move and if the computer cannot end the game immediately by making a quod. The BuildRedMoves procedure starts by scanning all the positions on the board (positions are stored by row and column coordinates). If a Red attacking piece is found, all the other positions are scanned to see if there is a second red piece. If one is found, the distance between the two points is calculated and stored in ColDiff and RowDiff.

Then BuildRedMoves computes the row and column coordinates of the potential third and fourth corners by using the ColDiff and RowDiff variables. If the third position is empty and the fourth position is Red, that means Red has three of four corners of a quod. The third, empty point is then stored in the RedWinningMoves array. Likewise, if the third point is Red and the fourth is vacant, then the fourth point is stored in the RedWinningMoves array.

You may be thinking, "But what about the square that is the mirror image of this one?"

BuildRedMoves considers this automatically because of its search method. As it progresses through the search, it will encounter the pair of corners a second time, but this time the second corner will be the first, and the first corner will be the second. This will reverse the signs in ColDiff and RowDiff, and thus the mirror-image square will be tested.

The algorithm for populating the BlueMoves array is very similar to that used for RedWinningMoves. The only difference is that for Blue, both the third and fourth positions have to be empty.

THE DECISION HIERARCHY

The decision-making functions called by Computer are named FirstTurn, BlueWinningMove, BlockOffensively, BlockWithBlocker, BlockWithAttacker, BlueAttack, BlockPotential, StartPotential, and Move. The source code for these functions is lengthy and not shown here, but it is available for downloading from PC Magazine Online along with the rest of the source code. The logic behind the functions, however, follows.

The first check Computer makes is to see if it's the first turn (the FirstTurn procedure). If so, there can be no real quod-making strategy other than playing toward the center of the board. As shown in the discussion about pivot points, the best positions to play are toward the center, since they offer the most square-making options. The closer a play is to the center, the more squares there are that can swing around that pivot point. If the center position isn't available, the position nearest to the center is next best.

In an early version of the game, I inserted first-play logic that did just that—tried to get as close as possible to the center position. (I couldn't assume the computer could take the center position, since the computer plays second and the opponent may have already taken that position.) When I submitted that beta version to the game's inventor for review, he pointed out that this strategy resulted in a boring game, because you ended up playing similar moves each time.

To give the game variety, I considered making the computer's first move any random empty position on the board. But that would have made the computer too stupid. So I decid-

ed on a compromise. The computer's opening play is semi-random in that the randomness is restricted to at most two positions off-center in both the horizontal and vertical directions. This simple solution met both objectives: a varied game and a challenging game.

If it is not the first move, Computer then checks to see if it has a winning move (the BlueWinningMove procedure). This involves checking all positions to see if Blue has made three of four corners toward a square anywhere on the board. If it finds a winning move, Computer makes the final corner and wins the game.

If there is no immediate win in sight for Blue, Computer then looks to see whether there's an immediate win in sight for Red, the opponent, that Computer must block. If

so, Computer then checks to see whether blocking with an attacking piece would make a potential square of its own (the BlockOffensively procedure). This is a strong move, because it accomplishes two things at once: It defensively blocks the opponent's winning position and offensively attacks with a potential square.

Even if Computer cannot block with an offensive move, it still must block the opponent's potential square. The question at this point is whether to use an attacking piece or a blocking piece. There are four steps in this decision-making process.

First, remember that a good general strategy is not to play blocking pieces too early in the game. For Computer, the number of turns to wait before playing a blocking piece is

stored in a variable called PreemptMoves. At the start of the game, PreemptMoves is assigned a random value between 0 and 4. Computer then waits until this many turns have been played before it considers using a blocking piece. The randomness of PreemptMoves lends some unpredictability to the computer's game.

There is one condition under which Computer will ignore PreemptMoves and play a blocking piece early: when the opponent has more

than one potential square. If this is the case, Computer must block all of them if it can, and this means using its blocking pieces.

If there is just one winning move for Red

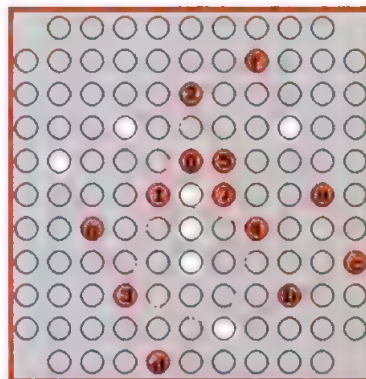


FIGURE 3: The "shooting star" pattern shown here is the best method for making double squares and is a very strong play.

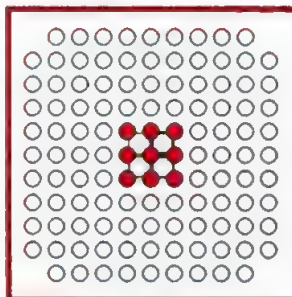


FIGURE 4: Using the center square as the pivot point, this diagram shows the four possible positions for the smallest-size squares.

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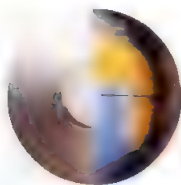
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and Computer has the green light to play a blocking piece, it does so if it also has an "almost winning move" (stored in the BlueMoves array) elsewhere on the board. Red is then blocked with a blocking piece, and an attacking piece is played at the position of the potential square.

The fourth and final consideration is whether Computer has run out of blocking pieces. If so, Computer can't play a blocking piece even if it wants to do so. If the opponent has two or more potential squares, Computer is doomed.

If none of the conditions are met for using a blocking piece, Computer blocks with an attacking piece (the BlockWithAttacker procedure). If the opponent has a winning move and this procedure is called, it means one of the following: Computer is out of blocking pieces, it's too early in the game to play a blocking piece, or Computer can't make a potential square.

If there are no winning moves for the op-

ponent, then Computer is free to attack if it can. It checks the BlueMoves array to see if there are any "almost winning moves" to make. If not, then Computer isn't yet in position to attack.

If Computer can't attack, it next checks to see if its opponent is getting ready to attack (the BlockPotential procedure). It does this by looking at the board to see whether Red has two corners of a potential square. If so, Computer spoils Red's fun by randomly placing an attacking piece on one of the two empty corners.

If Red isn't ready to attack, Computer readies itself to attack by trying to make the second corner of a square (the StartPotential procedure). It does this by treating each position it occupies as a pivot point and looking to see if the three other corners of the potential square are free. If so, Computer places an attacking piece on one of those positions.

If Computer runs through all the above tests and still doesn't find a move, it randomly

chooses an available board position and places an attacking piece there (the Move procedure).

QUOD VARIATIONS

In this program I've implemented the classic Quod game, but there are many possible variations. If you'd like to know more about these variations, you can send email to G. Keith Still at 100414.3265@compuserve.com. For information on some of Still's more recent work, see the Trends item "The Simple PC" in our issue of May 28, 1996.

If you come up with some nifty computer-play additions, post a message to me in the Utilities section of ZD Net's Tips forum or email me at 72241.161@compuserve.com. Still has beaten the computer at Quod, so I know the game is winnable. I, however, have not managed to do this—even though I wrote the program and know the computer's strategy. □

Michael J. Mefford is a contributing editor of PC Magazine.

GUIDE TO OUR UTILITIES

ABOUT QUOD...

DESCRIPTION Quod, a game invented by G. Keith Still, has simple rules, but playing well requires sophisticated strategy. The goal is to place pieces on a grid so that they form a square. The player who makes a square first wins.

DESCRIPTION Quod is played on an 11-by-11 square grid board with the four corners missing. Players take turns placing pieces on the board. Each player begins the game with 20 attacking (colored) pieces and 6 blocking (white) pieces. The object of the game is to outmaneuver your opponent and be the first to outline a square, called a quod, by capturing its four corners with your colored attacking pieces. You use the blocking pieces only for blocking your opponent's squares; they don't count toward making squares of your own.

On each turn you place one attacking piece on the board. Optionally, you can place any number of blocking pieces, up to the six allotted, before placing the attacking piece. If both players run out of attacking pieces before either has made a quod, the player with the most unplayed blocking pieces is declared the winner. If each has the same amount of blocking pieces (or if neither has any), the game is declared a draw. A winning square can be any size and orientation, and this is why playing Quod well requires strategy.

To install the Quod program, copy the files QUOD.EXE and QUOD.HLP to a subdirectory on your hard disk and create an icon for Quod in your shell. Quod is a 16-bit Windows program and will run under Windows 3.1, Windows 95, and Windows NT. When you launch Quod, you'll see a picture of a Quod board set up for a new game, with program controls along the right edge. You can obtain information on rules, strategies, and program operation by pressing the Help button.

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PC Solutions

TIPS AND TECHNIQUES TO INCREASE YOUR PRODUCTIVITY

User-to-User

By Neil J. Rubenking

Keep a Windows 95 Bug from Eating Your Filenames

I expect a new operating system like Windows 95 to have some bugs, but I've come across a really annoying one: In Explorer or any folder window, begin to edit a file or folder's name. Then—while still in edit mode—select View | Arrange Icons from the pull-down menu and choose a different sort order. Chances are good that by doing this, you'll screw up the name of another file or folder. Any ideas on how to prevent this?

KEVIN YIP, Flushing, New York

PC MAGAZINE: You can view this bug in action without risking filename damage, as long as you're careful. Open any folder window and click once on a filename, then click on it again. Two separate clicks (as opposed to a double-click) on a filename opens a tiny editor window for changing the name. Enter a new name, then use View | Arrange Icons to select a different sort order. Notice that the filename editor window does not move from its location in the window. Immediately press Esc to cancel the change.

What happens is that the files change order, but the filename editor window remains in the same location. If you press Enter or click outside the filename editor window, the file that's at that location in the current sort order will have its name changed. Suppose the files are ordered by size, and you're editing the name of the fifth file. If you now sort the files by date and press Enter, you'll change the name of the fifth file in date order. Press Esc and the change will be canceled with no harm done.

One way to avoid this problem is to get into the habit of using the right-click pop-up menu to arrange icons in a folder. When you right-click the folder window outside the filename editor window, the name change is completed and the editor window goes away. Now reordering the files won't have any undesirable side effects. If you do get caught by this bug, don't panic! As long as the editor window is still active, you can cancel the change by pressing Esc.

Teach Your New DOS an Old Trick

While there are many ways to build a secondary batch file from within a primary batch file, every approach I've encountered has fundamental drawbacks. I've found what I think is a better way.

Including indentation in a batch file has no effect on its execution, as COMMAND.COM ignores unnecessary spaces in front of a command. But well-formatted batch files are easier to read, so I decided to edit mine to remove the extra spaces. I used the TYPE command with the FIND filter to look for the lines that had too many spaces. I then realized that I could redirect those lines according to how many spaces they had in a row. Therein lies the key to my technique.

To embed a secondary batch file within a main batch file, type a GOTO command followed by its destination label. Between the command and the label, insert the lines of the secondary batch file, prefixing each with the same number of spaces (at least two). Since the GOTO command jumps over these lines, they are never executed by the main batch file. The neat thing about this is that there are no limitations on what characters the secondary batch-file lines can contain.

The main batch file creates the secondary batch file using a line like this:

```
TYPE MAIN.BAT | FIND " " | FIND " "
  > /V >2NDARY.BAT
```

There are two spaces between the first pair of double quotes and three spaces between the second pair. The first FIND command selects all lines that contain two or more spaces, and the second, using the /V switch, rejects lines that contain three or more. If necessary, you can embed more than one secondary file by prefixing the lines of each with a different number of spaces.

I created the batch file in Figure 1 by combining the above technique with a technique for parsing strings using the CHOICE command that was presented in the January 9, 1996, column. This batch file strips the first character from a string and returns both the character and the remainder of the string. In

HIGHLIGHTS



HARDWARE Here are a few quick workarounds to try if you're having problems printing graphics documents to a LaserJet from your Windows 95 system. Page 246



WORD PROCESSING How and why it's possible to use field codes to create two sets of page numbers in Word for Windows. Page 248



DATABASES Paradox for Windows doesn't have the ability to eliminate blank lines on a form, but we've found a way to do it. Page 254

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```

::SNAP.BAT
::Accepts a string as a parameter
::Returns %STR1% (first char) and %STR2% (rest)
@ECHO OFF
GOTO START
::BUILD
  ::SNAP$$$2.BAT
  IF "%2"=="?" RET
  SET STR1=%2
  :STR2
  IF "%3"=="?" RET
  SET STR2=%STR2%%3

```

```

SHIFT
GOTO STR2
:START
TYPE C:\BAT\SNAP.BAT |FIND " " |FIND " " /V
=>C:\BAT\SNAP$$$2.BAT
REM > C:\BAT\RET.BAT
ECHO:; |CHOICE/S/C:%1: C:\BAT\SNAP$$$2
=>C:\BAT\SNAP$$$1.BAT
SET STR2=
CALL SNAP$$$1
DEL C:\BAT\SNAP$$$?.BAT
DEL C:\BAT\RET.BAT

```



FIGURE 1: This batch file returns the first character of a passed string and the remainder of the string. (=> indicates a continued single line.)

```

::CHOP.BAT
::first parameter is string to split
::Second parameter is a string of x's
::Splits first string into %STR1% and %STR2%
:: where length of %STR1% matches length of 2nd
:: parameter
@ECHO OFF
IF '%2'==' ' %0 %1 x
IF EXIST C:\BAT\CHOP$$$2.BAT GOTO Quick
GOTO START
::BUILD
  ::CHOP$$$2.BAT
  IF "%2"=="?" RET
  SET STR1=%STR1%%2
  :STR2
  IF "%3"=="?" RET
  SET STR2=%STR2%%3
  SHIFT
  GOTO STR2

```

```

:START
TYPE C:\BAT\CHOP.BAT |FIND " " |FIND " " /V
=>C:\BAT\CHOP$$$2.BAT
SET STR1=
SET Count=
REM > C:\BAT\RET.BAT
:Quick
ECHO:; |CHOICE/S/C:%1: C:\BAT\CHOP$$$2
=>C:\BAT\CHOP$$$1.BAT
SET STR2=
CALL CHOP$$$1
SET Count=%Count%x
IF NOT '%Count%'=='%2' %0 %STR2% %2
SET Count=
ECHO STR1="%STR1%"
ECHO STR2="%STR2%"
DEL C:\BAT\CHOP$$$?.BAT
DEL C:\BAT\RET.BAT

```



FIGURE 2: CHOPBAT, a variation on SNAPBAT, splits its first parameter into two parts; the second parameter is a string of x characters defining the desired length for the first part.

DOS versions before 7, a quirk of the FOR command could be used to do this. DOS 7 removed this quirk, but a batch file like this one can replace it.

RICHARD A. ELLINGSON,
Paradise, California

PC MAGAZINE: This technique for creating secondary batch files has virtually no limitations and works with all modern DOS versions. You can create and test the secondary batch file separately, then incorporate it directly into the main batch file, as long as it doesn't contain any labels with the same name as labels in the main batch file.

Batch files that rely on auxiliary files will fail if one of those files goes missing. Also, since every file on disk occupies at least one cluster of disk space, a batch file solution that uses many small files is relatively wasteful. For these and other reasons, batch file experts frequently write a main batch file so it generates any necessary secondary files itself and deletes them when they're no longer needed.

The simplest way to generate a secondary

file is to redirect the output of the ECHO command for each line, replacing any percent signs with doubled percent signs. Using redirection symbols in the lines of the secondary batch file, however, requires difficult and complex batch file programming.

The absence of the FOR command quirk mentioned here is one of a number of reasons that batch files written for older DOS versions often fail under DOS 7 (the DOS version that Windows 95 uses). To see the problem, enter this command at a DOS prompt:

```
FOR %v IN (/Neil) DO ECHO %v
```

In DOS versions before DOS 7, this command would echo "N" and "eil" separately, and batch files could use this behavior to split off the first character of a string. Advanced batch files extended this technique to perform complicated string formatting. Alas, under DOS 7 the same command echoes the single string "/Neil", and all batch files that rely on the earlier behavior fail.

The SNAP batch file in Figure 1 emulates

the old FOR command behavior, returning the first character of the passed string in the STR1 environment variable and the remainder in the STR2 environment variable. String-parsing batch files can CALL SNAPBAT to avoid relying on the FOR command quirk. Figure 2 is CHOPBAT, a variation on SNAPBAT that splits the passed string into two parts. Its second parameter is a string of x characters that is of the desired length for the first part. For example, the following command would return "Mag" and "azine":

```
CHOP Magazine xxx
```

CHOPBAT uses its secondary batch file repeatedly, so it saves time by skipping the creation step when possible. Both of these batch files assume the existence of the directory C:\BAT on the PATH; change this if you store your batch files in a different directory.

You can download both of these batch files from PC Magazine Online. See the sidebar "Guide to Our Utilities" in this issue's Utilities column for instructions.

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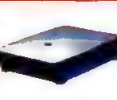
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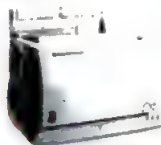
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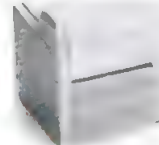
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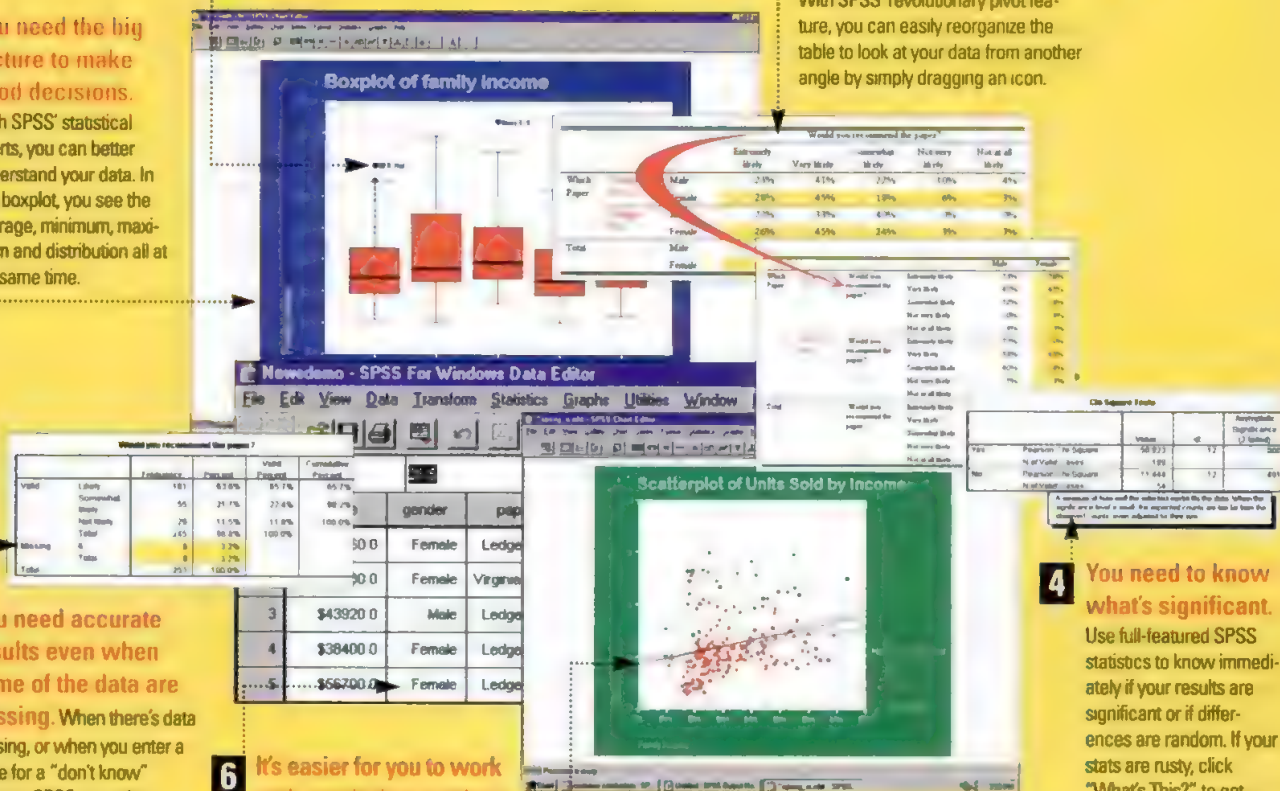
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Ask Our Advisors

HARDWARE

Nattering Notebooks



I need a good quality text-to-speech device for my portable computer, something that will either attach to the parallel port or plug into the PC-Card slot. I do a lot of work with textual and numeric data and want the computer to read it aloud so I can proof it more accurately and quickly. The product should be able to produce the words accurately and intelligibly—something equivalent to a child's toy won't do. Can you recommend a solution?

STAN FOSTER, E. Lansing, Michigan

PC MAGAZINE: The answer is actually pretty simple. Parallel-port sound devices are generally limited in terms of performance and sound quality, so you'll want to take a look at the new crop of sound card devices designed to fit in PC-Card slots. These can provide both digitized sound and MIDI support (as well as SCSI interfaces and game ports in some cases), making them the equivalent of a typical sound card you'd use in a desktop system.

The other part of the equation is the text-to-speech software. Many cards include such a utility as part of the standard software bundle, and a number of standalone products are available as well, with prices ranging from \$50 into the thousands. These products have improved a great deal in recent years, though you're still not likely to mistake them for a human voice reading your data. But they're able to read text files well enough for you to understand them, which should be sufficient for your application.—*Alfred Poor*

LaserJet Lock-up

I recently acquired a new computer running Windows 95, and I'm encountering some printer problems. While text documents seem to print without difficulty, graphics pages that printed on my HP LaserJet 4L (with 1MB of memory) under Windows 3.1 now lock up my printer. HP suggested using the LaserJet III driver, but that results in an extra blank page for every printed page. Can you suggest a better solution?

KENNETH KALBERG,
Schaumburg, Illinois

PC MAGAZINE: The short answer is that you probably don't need a new driver; you should have everything you need right at hand. For the complex graphics pages, you should be able to use the LaserJet 4L driver that comes with Windows 95. The problem you're experiencing is most likely caused by the print data stream overrunning your printer's controller. If you change the printer's settings in Windows 95, you may be able to get it to work properly.

First, open the Properties window for the printer (use the Printers icon in the Control Panel), and in the Details tab, choose Spool Settings and then "RAW" for the Spool Data Format. In the Device Options tab, move the memory tracking slider all the way to the Aggressive setting, and in the Graphics tab, select Use Raster Graphics for Graphics mode. In the Fonts tab, choose Print TrueType as graphics.

You can find out what each of these changes does by highlighting the option and pressing the F1 key, or by pressing the question-mark button in the caption bar and then clicking the option. Windows 95 opens a message window explaining the differences between the choices. For example, when EMF is your Spool Data Format, you're using a metafile format that returns

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control to your printer more rapidly, while the RAW setting produces an output format specific for your printer that may result in slower performance.

These changes will slow print performance, but at least your print jobs should print. If the changes solve the problem, you can start reversing them one at a time to see which settings will give you better performance without crashing your printer. Since you haven't had problems with text anyway, try changing the TrueType as graphics to TrueType as bitmap soft fonts first, as this will have the most significant impact on text print jobs.

In case these changes don't solve your printing problems, let's see if we can eliminate the extra page you get when using the LaserJet III driver. The extra page could be the result of having your parallel port configured as a PS/2-style port instead of the standard LPT, ECP, or EPP modes. If you can reconfigure your parallel port through your system BIOS, this may provide the solution.

You can also try using a newer version of the printer port protected mode driver for Windows 95. Start by checking the properties for LPT.VXD in your WINDOWS\SYSTEM subdirectory (highlight the file in Explorer and right-click on the filename). Look at the Version screen, and if your file has a version number lower than 4.00.503, make a backup copy of the file and then copy the newer version from the DRIVERS\PRINTERS\LPT directory on the Windows 95 CD-ROM. Restart Windows and the problem should be eliminated.—*Alfred Poor*

OPERATING ENVIRONMENTS

Maximizing Your Compressed Drive



Can you explain how DoubleSpace selects an estimated compression ratio for a hard disk? The allowable range for this ratio varies wildly from machine to machine, and the compressibility of the files on the disk does not appear to be one of the deciding factors.

I have a 425MB disk, 422MB of which is devoted to the compressed volume file. With 170MB on the compressed drive, DoubleSpace from DOS 6.20 reports a compression ratio of 2.0 to 1 and an estimated ratio of 1.3 to 1. DOS reports 512MB of total disk space. When I try to change the estimated compression ratio, I'm prompted to "Enter a number between 1.0 and 1.3." Any number out of this range is rejected. DOS cuts me off at 512MB, no matter what compression ratio I enter.

I feel cheated. DoubleSpace has compressed my files, but it won't let me use most of the space it created because of a technicality. Is there a way I can utilize this space?

ROB NICHOLS, Rocky Point, New York

PC MAGAZINE: You've put your finger on the source of the trouble (DoubleSpace cuts you off at 512MB. Both DoubleSpace and its successor, DriveSpace, use 8K clusters internally and are still subject to the File Allocation Table limitation of no more than 65,536 clusters. Multiply the cluster size by the maximum number of clusters and you get 512MB, the maximum size for a DoubleSpace drive. Divide 512MB by your compressed volume file size of 422MB and the result is close to the proposed 1.3 to 1 ratio.

Thus, the maximum sensible size for the compressed volume file is 512MB divided by the compression ratio you expect. If you expect a compression ratio of 2.0 to 1, you'd be better off allocating your 422MB of disk space to two compressed volume files, each smaller than 256MB.

Note that the DriveSpace 3 update included in the Windows 95 Plus! Pack raises this limit to 2GB. If your expected compression ratio is 2.0 to 1, you can compress an entire 1GB drive without worry or waste. DriveSpace 3 also adds more control over the compression process, including the ability to perform the initial storage of files without compression and compress them later when the system is idle.—*Neil J. Rubenking*

WORD PROCESSING

Dual Page Numbering In Word for Windows



When working with long technical documents, you often need two sets of page numbers, one set for the section and the other for the complete document. Word for Windows doesn't have a built-in dual page-numbering command, but there is a way to use field codes to add page numbers.

First, place these two field codes at the start of the document:

```
{SEQ variable1 \h \r {SectionPages} }
{SEQ variable2 \h \r0}
```

Next, set the entire document to restart numbering at page 1 for each new section. To do this, use Ctrl-NumPad 5 to select the entire document, choose Insert | Page Number, click on the Format button, and then set the Page Numbering box to start at 1. (This will enter a {Page} field in the footers, which you can remove if you like.)

Place the following field codes at the beginning of each section in the document after the first one:

```
{SEQ variable2 \h \r {=SEQ
variable1 \c} } }
{SEQ variable1 \h \r {= {SectionPages}+
{SEQ variable2 \c} } }
```

The following will place the page number of the current section in the headers or footers:

{Page}

Finally, the field code:

```
{= {SEQ variable2 \c} + {Page} }
```

will give you page numbers for the entire document.

MATTHEW POLLACK,
Eldridge, Maryland

PC MAGAZINE: This technique works as promised; however, the reason it works may not be immediately obvious. Let's go through it step by step, starting with the result and then figuring out how we got there.

To enter fields, simply press Ctrl-F9, which inserts the field code markers, and then type the text between the markers. For nested fields, you can enter markers within markers the same way.

The {Page} field is designed to give the page number in the current section. What's missing is a way to track the overall page number separately. This field manages that trick:

```
{= {SEQ variable2 \c} + {Page} }
```

This sets the value of the SEQ, or sequence field, to match the total number of pages in previous sections and adds that value to the {Page} field in order to get the total number of pages.

For this to work in the first section, the SEQ field must have a value of 0. That's a little tricky, because the SEQ field's primary job is to let you number items in sequence. If you enter the field {SEQ variable} three times in a row, the field results will be 1, 2, and 3. But the \c switch in the SEQ field for overall page number tells the field to repeat the current value for the variable rather than increment it. So all you have to do is make sure that variable2 is set to 0 at the beginning of the document.

That's precisely what this field at the beginning of the document does:

```
{SEQ variable1 \h \r {SectionPages} }
```

The \r switch sets the value for the variable named in the SEQ field, setting it to whatever number you enter immediately after the switch. So the \r0 in the following field sets variable2 to 0:

```
{SEQ variable2 \h \r0}
```

Getting the correct starting number for later sections is a bit harder, but that's what the rest of the fields are for. The first field at the beginning of the document takes advan-

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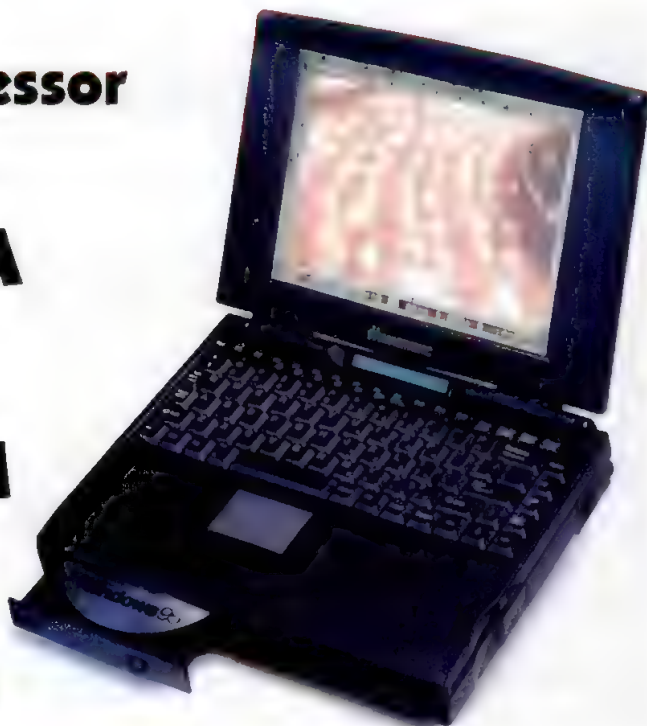
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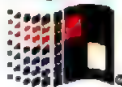
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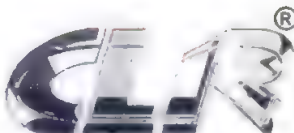
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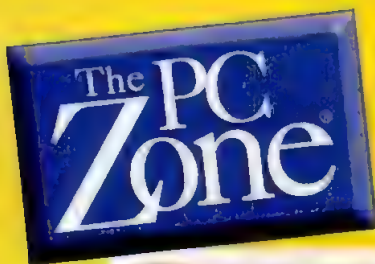
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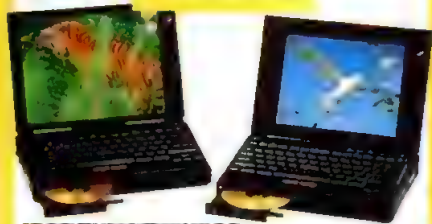
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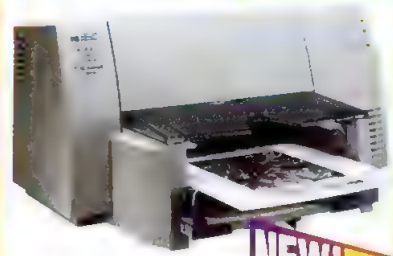
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tage of the {SectionPages} field, which returns the number of pages in the current section. More precisely, it uses the \r switch to set variable1 to the number of pages in the first section.

The first field at the beginning of the second section resets variable2 to match the number of pages in the first section (by setting it to match the current value of variable1):

```
{SEQ variable2 \h \r {={SEQ  
variable1 \c} } }
```

This makes the field for overall page number in the header become the number of pages in section 1 plus the {Page} field.

The second field at the beginning of the second section resets variable1 to match the number of pages in section 1 plus the number of pages in section 2:

```
{SEQ variable1 \h \r {={SectionPages}+  
{SEQ variable2 \c} } }
```

For all later sections, the same pattern repeats. The first field resets variable2 to match the number of pages in previous sections, so you can calculate the current page right in the header. The second field resets variable1 to match the number of pages in previous sections plus the current section.

The only part I haven't mentioned yet is the \h switch. This hides the field results so that the fields in the document itself won't show on screen or on the printed page.

An important drawback of this technique is that if you leave the fields hidden, you can easily delete one or more fields accidentally and ruin the numbering. One way around that is to set Word to show all fields. Alt-F9 will toggle between showing fields and showing field results.

There is another way to get dual page numbers, but since we don't have the space to discuss it in detail, I'll briefly summarize it. The alternative involves adding a bookmark to each section break, using different headers in each section, and calculating the number of pages in previous sections using the {PageRef} field. Since the bookmark is marking the section break, you would have to delete the section break to delete the bookmark, which you're not likely to do.

If the bookmarks are named EndSec1, EndSec2, and so on, the field for the overall page count in section 2 would be {={PageRef EndSec1}+{Page}}, the field for section 3 would be {={PageRef EndSec1}+{PageRef EndSec2}+{Page}}, and so on. The drawback to this approach is that the fields get unwieldy after a few sections and you may have to revise them if you delete or move a section. The good part is you won't have to worry about accidentally deleting a field.

—M. David Stone

SPREADSHEETS

Exporting an Excel Workbook to a Text File



Someone in my organization created a catalog order-entry workbook in Excel that displays products and allows the salespeople in the field to enter quantities. The spreadsheet does some rudimentary calculations and prints a nice copy of the order. The salespeople love it. Unfortunately, when it gets back to the office, it needs to be uploaded into the company mainframe—and here is where the problems begin. Microsoft says it's not possible to export the whole workbook at once; it must be done one worksheet at a time. Each order can contain up to 79 worksheets, though, so that's not very feasible.

I can write a macro that strips off the headings of each sheet and puts all the lines that have quantities entered in them on one sheet, which can then be exported. But my macro would be specific to the catalog; that is, new catalog information would require building a new macro, and that's not very practical either.

Can you tell me if there's a generic way to get all the sheets of the workbook dumped out into a flat file that can then be exported to the mainframe?

DONALD J. VARNEY, Newport, Vermont

PC MAGAZINE: I assume your mainframe needs a plain ASCII file, and you're quite right—Excel's text-export routine works on the current worksheet only. (For the sake of comparison, you might be interested to know that the equivalent command in Lotus 1-2-3 Release 5 operates on all pages of the current spreadsheet file. Quattro Pro, on the other hand, behaves the same way as Excel.)

My suggestion is to install the Windows Generic / Text Only printer driver, set the driver so it prints to a file, then print to that driver. That will get you a plain-text file, suitable for uploading to the mainframe. And unlike the official text-export routine, the Print command can be applied to entire workbooks (or any set of particular sheets).

Before you print your workbook to a file, you might want to use Excel's Page Setup command to set your top, bottom, left, and right margins to zero. That will reduce extraneous white space. Consider, too, whether you want headers and footers. If your pages are short, you might want to let Excel print the sheet name as a header for each sheet in your workbook. On the other hand, if your sheets run to multiple pages, such headers will give you unwanted text in the middle of your data.

Finally, be sure your columns have adequate width. Because the fonts used on screen

may be narrower than the font used by the Generic / Text Only printer driver, some columns that look fine in Excel may show up as number signs in your print-out. You can circumvent this problem by widening your columns before printing.—Craig Stinson

DATABASES

Colorful Code in Visual FoxPro



Microsoft has color-coded syntax editing in Visual Basic's editor, but this feature is inexplicably absent in Visual FoxPro. FoxPro exposes hooks that let third-party vendors tap into the editor, so it seems logical that someone might add this feature externally. Do you know of any third-party packages that add color to FoxPro's editor?

KAREN ABRAHAM
Atlanta, Georgia

PC MAGAZINE: I know of only one, a shareware package called XiLights, which you can download from CompuServe. The product is a FoxPro add-on library that comes in two versions, one for Visual FoxPro and one for Microsoft FoxPro for Windows. You load it via the SET LIBRARY TO command, and it thereafter adds color to the Editor, Command, and Trace windows.

You can assign individual colors to eight different code elements:

- user text
- FoxPro keywords like USE or BROWSE
- string constants
- numeric constants
- flow constructs like DO WHILE or DO CASE
- comments
- compiler directives (like #define)
- system variables

XiLight's default colors were evidently designed to emphasize a splash of color, so you'll probably want to change them to suit your own style. Figure 1 shows a sample using the default colors.

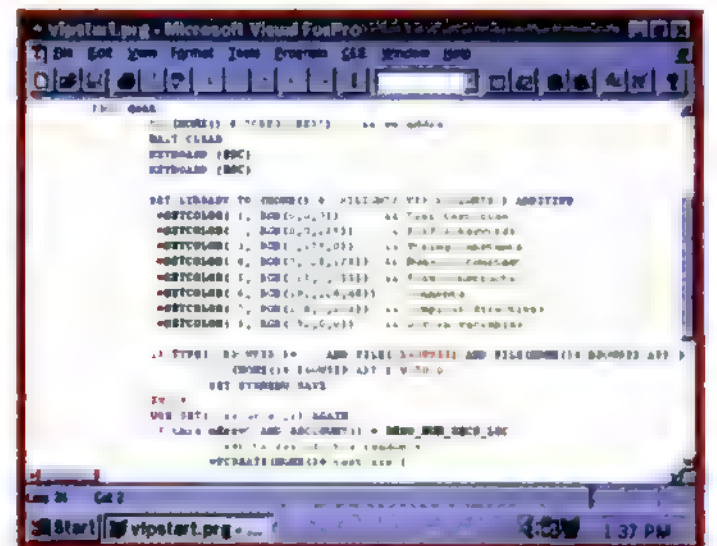


FIGURE 1: You can add a touch of color to FoxPro or Visual FoxPro's editing environment using a shareware package called XiLights.

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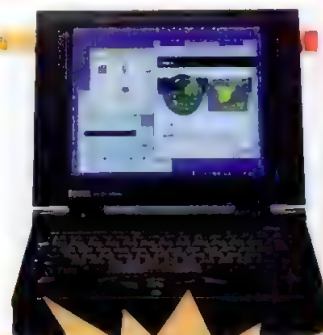


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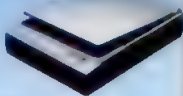
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Microsoft Carbon Copy V3.0 WIN95		</


```
--[Line Two]
iff([Table.Address Line 1]="",
    iff([Table.Address Line 2]="",
        [Table.Address Line 3],
        [Table.Address Line 2]),
    [Table.Address Line 1])

--[Line Three]
iff([Table.Address Line 1]="",
    iff([Table.Address Line 2]="", [Table.City]+",
        "+[Table.State]+
        " "+[Table.Zip],[Table.Address Line 3]),
    [Table.Address Line 2])

--[Line Four]
iff([Table.Address Line 1]="",
    iff([Table.Address Line 2]="", [Table.Country],
        [Table.City]+", "+[Table.State]+" "+[Table.Zip]),
    [Table.Address Line 3])

--[Line Five]
iff([Table.Address Line 1]="",
    iff([Table.Address Line 2]="", "", [Table.Country]),
    [Table.City]+", "+[Table.State]+" "+[Table.Zip])

--[Line Six]
iff([Table.Address Line 1]="", "",
    [Table.Country])
```



FIGURE 2: You can use If logic to close up blank spaces in an address on a form, provided you store the address with the blank address lines first.

You can set the colors via an .INI file or using the supplied SETCOLOR function. You can also turn color on and off without unloading the library using the COLORMODE function. XiLights is shareware, and as such you are encouraged to register via a reminder that pops up now and then. You'll want to register quickly, because the reminders are definitely annoying. The \$45 price seems a little high for this type of utility, but you might find the color-coding easier on your eyes and therefore worth the price.

To give XiLights a try, download a copy from the Visual FoxPro forum on CompuServe (GO CIS:VFOX). Look in the FLL library. Or contact the authors at one of the following addresses: Xitech Inc., 4222 Airport Hwy, #4, Toledo, OH 43615; 419-382-0001; or Xitech, The Lindens, Chantry Lane, Hatfield, Herts, AL10 9PH, U.K.; phone, +44 1707 276637.

—Sal Ricciardi

Suppressing Blanks in Paradox Forms

Paradox for Windows has the ability to eliminate blank fields and lines on a report, but there is no way to delete them on a form. Because I wanted the records in our public online address list to appear on a form without intervening blank lines, I came up with a way to suppress the blank lines.

Our addresses consist of a name and from one to three address lines, followed by a line for city, state, and zip code and a line for country. In an attempt to make the addresses look less "computerized," I use unlabeled fields and place each component of the address in a text box on a separate line. A sample address on my form might look like this:

David Hume	Name
	Address line1
	Address line2
1035 5th St.	Address line3

Bronx, NY 23534	City, St, Zip
USA	Country

Note the two empty address lines. To eliminate the blank lines that result from empty address lines, I make each line below the name a calculated field using embedded Immediate IF statements as shown in Figure 2. Each calculated field adjusts its output depending on the contents of the fields that appear earlier in the address. Thus, the sample address on the form becomes:

David Hume	Name
1035 5th St.	Address line3
Bronx, NY 23534	City, St, Zip
USA	Country
	Address line1
	Address line2

For the technique to work, the field objects on the form should be arranged like this:

```
Name
[FORMULA]
[FORMULA]
[FORMULA]
[FORMULA]
[FORMULA]
```

Each formula corresponds to the If statements in Figure 1. The technique works fine in Paradox for Windows, Versions 4.5 and 5.0.

BERNARD PEGIS,
Santa Paula, California

PC MAGAZINE: You can remove blank lines in Paradox reports through skillful use of the "Delete when empty" Run-Time property, but there's no equivalent property for objects on Paradox forms. The technique shown here relies on changing field objects into calculated fields. To change a field object into a calculated field, you right-click on the field object, choose Define Field, check the Calculated check box, and then enter your formula in the

text box just below the Calculated check box.

Mr. Pegis's technique is for a form that provides read-only access to the address information. It relies on the fact that the address line information stored in the table is pushed down so that empty address lines rise toward the top. For instance, the street address in the example, "1035 5th Street," is stored in the table in address line three, not address line one as you might expect. This characteristic makes possible the logic shown in Figure 2, which has the effect of floating address lines toward the top to eliminate blank lines. The logic works only if the address lines in the table are filled from the bottom up. For this reason you'll have to train your users to enter the street address in line three or use Object PAL code to rearrange the data correctly after data entry.

You can download the code mentioned here from PC Magazine Online. See the sidebar "Guide to Our Utilities" in this issue's Utilities column for instructions.

—Sal Ricciardi

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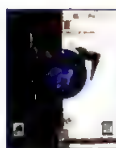
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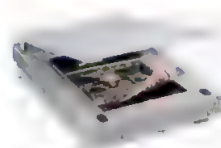
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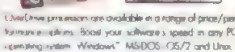
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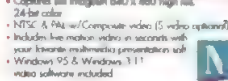
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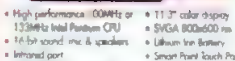
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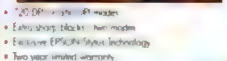
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ThinkPad® 760EL and 760ELD

Processor	Screen	RAM/MB	Price
Pentium 70	12.1" Active SVGA	8/512MB	\$3399
Pentium 70	12.1" Active SVGA	8/512MB	4499*
Pentium 70	12.1" Active SVGA	8/512MB	3599
Pentium 70	12.1" Active SVGA	8/512MB	4799
Pentium 70	12.1" Active SVGA	8/512MB	5499

* Includes built-in 4X CD-ROM drive

ThinkPad® 760E and 760ED

Processor	Screen	RAM/MB	Price
Pentium 70	12.1" Active SVGA	8/512MB	\$4999
Pentium 70	12.1" Active SVGA	8/512MB	\$1999
Pentium 133	12.1" Active SVGA	16MB/1.2GB	\$999
Pentium 133	12.1" Active SVGA	16MB/1.2GB	6999*

* Includes built-in 4X CD-ROM drive

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**Additional ThinkPad 760 models available.
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ThinkPad® 760L and 760LD

- 10.4" Active display
- 32-bit accelerated local bus video
- Built-in sound card & speaker & microphone
- 256KB local cache
- Floating point with post-test

Processor	Screen	RAM/MB	Price
Pentium 90	10.4" Active	8/810MB	\$4249
Pentium 90	10.4" Active	8/810MB	4549*

* Includes built-in 4X CD-ROM drive
Windows 95 models also available



ThinkPad® 760LD

hp HEWLETT PACKARD®



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600 Notebook PC

HP OmniBook 600

- Weighs ONLY 3.8 pounds!
- Built-in 16-bit sound, microphone & speaker
- Built-in infrared for wireless communications
- Lithium Ion battery technology
- Instant ON - ready-to-work state - lasts for months on recharge

Processor	Screen	RAM/MB	Price
486DX4/75	9.5" Active	8/340MB	\$2499

Additional HP OmniBook models available! Call for details.

HP OmniBook 5500

- 133MHz Pentium with 32-bit PCI Local Bus
- 12.1" Active Matrix display with 65,000 colors
- Super VGA 800x600 resolution on notebook
- PCI Local bus video & SMI video monitor
- 16-bit stereo sound with 2 speakers
- optional 4X CD-ROM drive

Processor	Screen	RAM/MB	Price
Pentium 133	12.1" Active SVGA	16MB/1.35GB	\$5999



HP OmniBook
5500 Notebook PC

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AST Ascentia P

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- 11.3" Dual Scan Active Matrix display with 800x600 resolution
- 800MB & 1.2GB removable hard drives
- Built-in SoundBlaster 16Vx2 chip set

Processor	Screen	RAM/HD	Price
Pentium 100	11.3" Dual Scan SVGA	8/800MB	\$3299
Pentium 100	11.3" Dual Scan SVGA	8MB/1.2GB	3779
Pentium 133	11.3" Active SVGA	8/800MB	4249
Pentium 133	11.3" Active SVGA	8MB/1.2GB	4729

AST Ascentia J

- Integrated 14.4/14.4 Data/fax modem and audio
- PCI bus architecture with 256KB Level 2 cache
- 10.4" SVGA (800x600) resolution Dual Scan and Active display

Processor	Screen	RAM/HD	Price
Pentium 75	10.4" Dual Scan SVGA	8/500MB	\$2149
Pentium 100	10.4" Dual Scan SVGA	8/800MB	2639
Pentium 100	10.4" Active Matrix SVGA	8/800MB	2839
Pentium 133	10.4" Active Matrix SVGA	8/800MB	3299

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digital™ Digital HiNote VP

Processor	Screen	RAM/HD	Price
Pentium 100	10.4" Dual Scan	8/810MB	\$2399
Pentium 100	10.4" Active	8/810MB	2869*

*Includes 16-bit stereo sound, mic, & speaker (CTS 5100)

Digital HiNote Ultra II

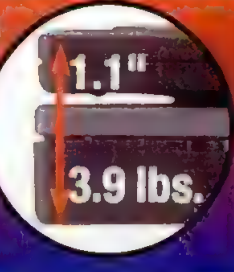
- Up to 133MHz mobile Pentium processor
- 256KB of internal Level 2 cache
- Oversized 10.4" Active Matrix display
- Built-in trackball with sculpted palm rest

HiNote Ultra II
Shown with external
floppy dock

Processor	Screen	RAM/HD	Price
Pentium 100	10.4" Active SVGA	8MB/1.08GB	\$3769
Pentium 120	10.4" Active SVGA	8MB/1.08GB	4059
Pentium 133	10.4" Active SVGA	8MB/1.35GB	4439



**Shown
Actual
Size**
(in closed
position)



TEXAS INSTRUMENTS

Extensa 560/570CD & CDT

Processor	Screen	RAM/HD	Price
Pentium 75	10.4" Dual Scan	8/810MB	\$2499
Pentium 75	10.4" Active	8MB/1.2GB	3499
Pentium 100	11.3" Dual Scan	8/810MB	2929
Pentium 100	10.4" Active	8MB/1.2GB	3909

TravelMate 5130/5270/5300

- Pentium 90, 120 & 133MHz processors
- 10.4" & 11.3" SVGA Active Matrix display
- Dual Lithium Ion batteries
- 32-bit PCI Local bus graphics
- 2MB video memory
- 256KB Level 2 cache
- 1280x1024 external monitor resolution
- 16-bit SoundBlaster compatible audio
- External PCI bus
- Windows 95 AND Windows for Workgroups

Processor	Screen	RAM/HD	Price
Pentium 90	10.4" Active SVGA	8MB/1.2GB	\$3499
Pentium 120	11.3" Active SVGA	8MB/1.2GB	4199
Pentium 133	11.3" Active SVGA	8MB/1.2GB	4499

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TravelMate 5270 & 5300
accessories promotion!**



TravelMate Series
Product differs slightly from photo

NEC

NEC Versa 2205

Processor	Screen	RAM/HD	Price
Pentium 75	9.5" Active	8/810MB	\$2499



4X Speed

NEC Versa 4000

NEC Versa 4000

- Built-in XCD-ROM drive (selected models)
- Up to 120MHz Pentium processors
- 256KB Level 2 cache to optimize performance
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- Built-in 16-bit sound, microphone, MIDI and 2 built-in speakers
- Multimedia docking station with outstanding AfterLasing® speaker array (optional accessory priced separately)

Processor	Screen	RAM/HD	Price
Pentium 75	10.1" Active	8/810MB	\$3799*
Pentium 90	10.4" High Res.	8/810MB	4099
Pentium 90	10.1" Active	8/810MB	4349*
Pentium 120	10.4" High Res.	8MB/1GB	4399

* Features built-in 4X CD-ROM drive

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Confura 430

Processor	Screen	RAM/HD	Price
486DX4/100	10.4" Dual Scan	8/720MB	\$2369
486DX4/100	10.4" Active	8/720MB	2869

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- Up to 1.45GB hard drives
- Built-in antenna for wireless communications
- Supports NMH batteries
- Optional MPEG and TV video adapter

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New Models!

Processor	Screen	RAM/HD	Price
Pentium 75	10.4" Dual Scan	8/510MB	\$2830
Pentium 75	11.3" Dual Scan	8/810MB	3210
Pentium 75	10.4" Active	8/810MB	3590
Pentium 90	10.4" Active	8/810MB	3970
Pentium 90	10.4" Active	8/810MB	4340*
Pentium 120	10.4" Active	8MB/1.35GB	4720
Pentium 120	11.3" Active SVGA	16MB/1.35GB	5099
Pentium 133	12.1" Active SVGA	16MB/1.35GB	5669

* Features Built-in 4X CD-ROM drive



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Processor	RAM/HD	CD-ROM	Price
Pentium 75	8/850MB	4X	\$1399
Pentium 75	8MB/1.2GB	4X	1449
Pentium 100	8MB/1.2GB	4X	1599
Pentium 120	16MB/1.6GB	4X	2199
Pentium 133	16MB/1.6GB	4X	2299
Pentium 150	16MB/1.6GB	4X	2349

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- LOADS of **FREE** software
- *4X CD-ROM on 7610

Processor	RAM/HD	CD-ROM	Price
Pentium 120	8MB/1.2GB	4X	\$1799
Pentium 133	8MB/1.2GB	6X	2199
Pentium 150	8MB/1.2GB	6X	1999
Pentium 120	16MB/1.6GB	6X	2499
Pentium 133	16MB/1.6GB	6X	2299
Pentium 150	16MB/2GB	6X	2799
Pentium 166	16MB/2GB	6X	2999

Monitors priced separately

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- 6X CD-ROM Drive w/3disc CD changer (selected models)
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- Integrated 3-D surround sound (selected models)
- 64 Bit PCI Local bus graphics
- AST Works II navigation software - featuring SPOT
- Enhanced IDE interface - fast disk performance

Processor	RAM/HD	CD-ROM	Price
Pentium 100	16MB/1.2GB	6X	\$1599
Pentium 133	16MB/1.2GB	6X	2149
Pentium 150	16MB/1.6GB	6X	2369
Pentium 100	16MB/1.2GB	6X	1699
Pentium 133	16MB/1.6GB	6X	2299
Pentium 150	16MB/2.1GB	6X†	2639
Pentium 166	16MB/2.1GB	6X†	2829

† w/3disc CD changer
Monitors priced separately

AST Advantage Adventure



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- HP DeskJet 320 (bundle) C2637A/ABA .. 199.99†
- HP DeskJet 600C printer C4547A .. 259.00†
- HP DeskJet 660C printer C2164A .. 359.00†
- HP DeskJet 660Cse printer C4548A .. 369.00†
- HP DeskJet 682C (4567A/ABA) .. 349.00†
- HP DeskJet 820Cse printer C3540A/ABA .. 399.00†
- HP DeskJet 855C printer C4551A .. 449.00†
- HP DeskJet 875Cse C4552A/ABA .. 499.00†
- HP DeskJet 1600C printer C3540A .. 1349.99†

Home Office Products

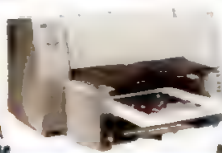
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- HP FAX-700 C3530A .. 509.99

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† Includes HP Color Kit

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- HP ScanJet 4S portable scanner (C1127A) .. 319.00

HP Tape Drives

- HP T1000 (internal) C4320RB .. \$ 169.00
- HP T1000e (portable) C4326RB .. 219.99
- HP SureStore, 2GB, DAT, Int C1525F .. 939.99
- HP SureStore, 8GB, DAT, Ext C1529F .. 1220.00



C3941A
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C4548A

HP DeskJet 660Cse

PCMB 6/96

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15" MultiSync M500	Multiscan 1550H	17" PantSync S17
15" MultiSync XV15+	Multiscan 1750H	17" PantSync 17929
17" MultiSync XV17+	Multiscan 1750H	21" PantSync C21929
21" MultiSync X271	Multiscan DVIII	
21" MultiSync X271		
21" MultiSync X271		
	CTX	MAG INNOVISION
	14" 1451C-1	14" B01495
	14" 1451C1B-1	15" B01595
	15" 1560B-1	17" B01795
	17" 1765GME-1	17" MXP17F
	17" 1765GME-1	21" MXP21F
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MultiSync 4K 7 Disk Changer	SoundBlaster Value CD 4X PnP	PE-450C 4X CD-ROM External
MultiSync 6X	Discovery CD 4X	
MultiSync 6X	SoundBlaster Performance 4X PnP	
	SoundBlaster 16 Value I/O PnP	
	SoundBlaster AWE 32 PnP	
	SoundBlaster 32 PnP	
	Advanced Signal Proc Upgrade Kit	
	Wave Master II	
		SONY
		SRS-PC40 Speakers
		SRS-PCV1
		SRS-PC2000 Speakers
		ESD 7405 (Dated SCSI) CD-ROM

Desktops Systems

NEC	AST
PowerMate Vx, Pentium 75, 8MB RAM, 635MB HD, Desktop	Advantage 623, Pentium 100, 8MB RAM, 1.2GB HD, Desktop w/ Monitor
PowerMate Vx, Pentium 100, 8MB RAM, 1.2GB HD, Desktop	Advantage 625, Pentium 133, 8MB RAM, 1.2GB HD, Desktop, 4X
PowerMate Vx, Pentium 100, 16MB RAM, 1.2GB HD, Desktop, 4X	Advantage 621, Pentium 100, 8MB RAM, 1.2GB HD, Mid-tower, 4X
PowerMate Vx, Pentium 100, 16MB RAM, 1.2GB HD, Mid-tower, 4X	Advantage 623, Pentium 133, 8MB RAM, 1.6GB HD, Mid-tower, 4X
PowerMate Vx, Pentium 100, 16MB RAM, 1.6GB HD, Mid-tower, 4X	Advantage 624, Pentium 133, 16MB RAM, 1.6GB HD, Mid-tower, 4X
PowerMate Vx, Pentium 133, 16MB EDO RAM, 1.2GB HD, Mid-tower, 4X	Advantage 628, Pentium 166, 16MB RAM, 2.1GB HD, Mid-tower, 4X
PowerMate Vx, Pentium 166, 16MB EDO RAM, 2.0GB HD, Mid-tower, 4X	

Models do not include monitor unless otherwise stated.

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T100CS	features Intel Pentium 75MHz processor, 10.4" Color Dual Scan Display, 504MB HD, 8MB RAM (Max. 40MB), Your choice, only \$1799
T105CS	features Intel Pentium 75MHz processor, 10.4" Color Dual Scan Display, 504MB HD, 8MB RAM (Max. 40MB), Your choice, only \$1799
T2150CST	features Intel 486 DX4 75MHz processor, 10.4" Color Active Matrix Display, 500MB HD, 8MB RAM (Max. 32MB), Your choice, only \$2499
TOSHIBA	SATELLITE Pro
T2115SCS	features Intel 486 DX4 75MHz processor, 10.4" Color Dual Scan Display, 520MB HD, 8MB RAM (Max. 32MB), With MS-DOS/Win 3.11 OR With Win 95...Your choice, only \$1999
T2115SCDS	features Intel 486 DX4 75MHz processor, 10.4" Color Dual Scan Display, 520MB HD, 4MB RAM (Max. 20MB), CD-ROM Drive...Your choice, only \$1599
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410CST	features Intel Pentium 90MHz processor, 11.3" Color Active Matrix Display, 810MB HD, 8MB RAM (Max. 40MB), CD-ROM Drive, Includes DOS/Win 3.11...\$4099
610CST	features Intel Pentium 90MHz processor, 9.5" Color Active Matrix Display, 720MB HD, 8MB RAM (Max. 40MB) Includes Win 95...\$3599
TECRA	
700CS	features Intel Pentium 120MHz processor, 11.3" Color Dual Scan Display, 1.2GB HD, 8MB RAM (Max. 40MB) Includes Win 95...\$3599
700CST	features Intel Pentium 120MHz processor, 11.3" Color Active Matrix Display, 1.2GB HD, 16MB RAM (Max. 40MB) Includes Win 95...\$4399

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Satellite Pro 410CS Pentium 90, Dual Scan, 810MB	\$3199
Satellite Pro 410CST Pentium 90, Act. Color, 810MB	\$4399
Portege 410CST Pentium 90, Active Color, 720MB	\$3899
Toshiba 700CST Pentium 120, Dual Scan, 1.2GB	\$3999
Toshiba 700CST Pentium 120, Active Color, 1.2GB	\$4999
NEW Tecra 710CST Pentium 133, 12.1" Active Color, 1.2GB, 4X CD-ROM, 28.8 Modem	\$6879
NEW Tecra 720CST Pentium 133, 12.1" Active Color, 1.2GB, 4X CD-ROM, 28.8 Modem	\$7429

TELES INSTRUMENTS

EXTENSA 510 Pentium 100, 10.4" Dual Scan, 810MB	\$2199
EXTENSA 540CST Pentium 75, 10.4" Dual Scan, 810MB	\$2299
EXTENSA 540CST Pentium 75, 10.4" SVGA Active, 1.2GB	\$2999
EXTENSA 570CST Pentium 100, 11.3" Dual Scan, 810MB	\$2999
EXTENSA 570CST Pentium 100, 10.4" SVGA Active, 1.2GB	\$3849
T5100 Pentium 90, 10.4" SVGA Color, 1.2GB	\$3379
T5200 Pentium 120, 10.4" SVGA Color, 1.2GB	\$4049
T5300 Pentium 133, 11.3" SVGA Color, 1.2GB	\$4629

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VERSA 2205C Pent. 75, 9.5" Active Color 810MB, 14.4 Modem	\$2499
VERSA 4000X Pentium 75 Active Color 810MB 4X CD-ROM	\$2799
VERSA 4050H Pentium 90 Active Color 810MB 4X CD-ROM	\$4499
VERSA 4000H Pentium 120 Hi-Res Color 1.2GB	\$4999

IBM ThinkPad

365E SX36, 10.4" Dual Scan, 540MB	\$1999
365ED SX36, 10.4" Dual Scan, 540MB, 4XCD	\$2499
365XZ Pentium 100, 10.4" Dual Scan, 810MB, 4XCD	\$2799
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365XZ Pentium 100, 10.4" Active, 810MB	\$2899
365XZ Pentium 120, 10.4" Active, 1.0GB, 4XCD	\$3499
365XZ Pentium 120, 11.3" Dual Scan, 1.0GB, 4XCD	\$3299
740ED Pentium 133, 12.1" Active, 1.2GB, 4XCD	\$4999
740E Pentium 120, 12.1" Active, 1.2GB	\$5199
740E Pentium 133, 12.1" Active, 1.0GB	\$5999
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QUANTUM	535 MB SCSI	\$165
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11 ms Seek		
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QUANTUM	840 MB E-IDE	\$187
11 ms Seek		
QUANTUM	850 MB SCSI	\$189
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QUANTUM	1280 MB E-IDE	\$226
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WESTERN DIGITAL	1280 MB E-IDE	\$237
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CONNER	1060 MB SCSI	\$245
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CONNER	1275 MB E-IDE	\$243
14 ms Seek		
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8 ms Seek • 7200 RPM • 512K Buffer		
QUANTUM	4.3GB Atlas	\$957
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2149MB	Hawk 2XL	9ms	512	5,411	40Mbytes	3.5" 1"H	Ultra Wide SCSI	5 Year	ST32155W	659.99
2150MB	Cayman	8.5ms	512	7,200	10Mbytes	3.5" 1"H	Fast SCSI-2 A/V	5 Year	ST32107N	679.99
4294MB	Hawk 4	9ms	512	5,411	10Mbytes	3.5" HH	Fast SCSI-2 A/V	5 Year	ST15230N	979.99
4294MB	Cayman	9ms	512	7,200	10Mbytes	3.5" HH	Fast SCSI-2 A/V	5 Year	ST14207N	899.99
Performance Drives—										
2147MB	Barracuda 2LP	8ms	512	7,200	10Mbytes	3.5" 1"H	Fast SCSI-2 A/V	5 Year	ST32550N	765.99
2147MB	Barracuda 2LP	8ms	512	7,200	20Mbytes	3.5" 1"H	Fast Wide SCSI-2 A/V	5 Year	ST32550W	819.99
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4294MB	Barracuda 4	1.024	1,024	7,200	20Mbytes	3.5" HH	Fast Wide SCSI/SCA	5 Year	ST15150WC	1,149.99
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4300MB	Capricorn	8.5ms	512	7,200	20Mbytes	3.5" HH	Fast Wide SCSI-2 A/V	5 Year	MC3243AVW	1,249.99
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2100MB	Ultrastar	7.5ms	512	7,200	10Mbytes	3.5" 1"H	Fast SCSI-2	5 Year	IB94G3054	\$1,049.99
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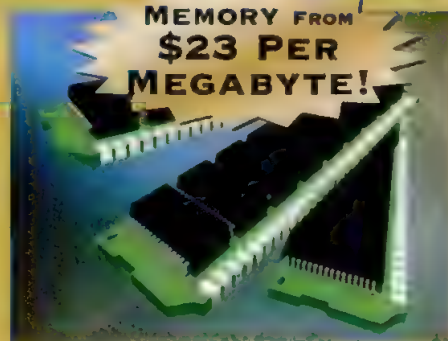
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Mass Storage Devices.....	290	
Multi-Media.....	291	
Music/Midi.....		291
Networking.....	292	
Peripherals.....	292, 293	
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DX4 133	79	3v	33MHz	131-5v
Intel 486				
DX2-66	69	5v	33MHz	N/A
DX4 100	100	5v	33MHz	N/A
Pentium®				
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90MHz	125			
100MHz	155			
120MHz	215			
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2004MB	E-IDE	12ms	128K	4480	MX72004A	305

NOTEBOOKS

NEC Versa 4000D

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4080H	P-120	10.4" Active	8/1gb	\$4960

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6000 CT	486 DX4-75	9.5" Active	8.340	\$2499

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486 All 486 CPU's are 3-socket and have 68 Pins and can be used on these boards. Get Simm Venter™ for only \$22 each when you buy a Motherboard.

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MBTranquility	\$199	256K	Pipeline	3	4	4	Intel Triton	AMI	Serinity
MBP55CMS-256	\$225	256K	Pipeline	4	4	4	Intel Triton	AMI	Super Micro
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MBATLANTIS	\$319	256K	Pipeline	4	4	4	Intel Triton	AMI	Intel

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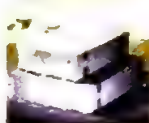
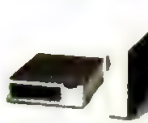
All Pentium Pro CPU's are 8 socket and have 385 pins. These should only be used in a Network Environment

Model No.	Price	Cache Size	Cache Type	PCI Slots	ISA Slots	72 Pin	Chipset	BIOS	Manufacturer
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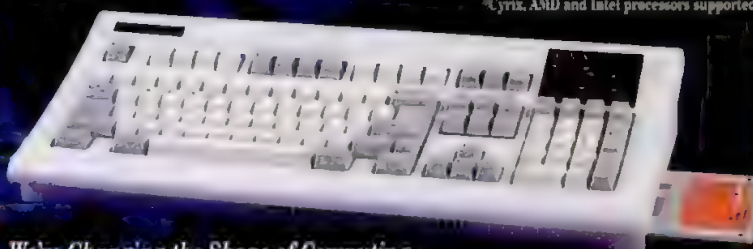
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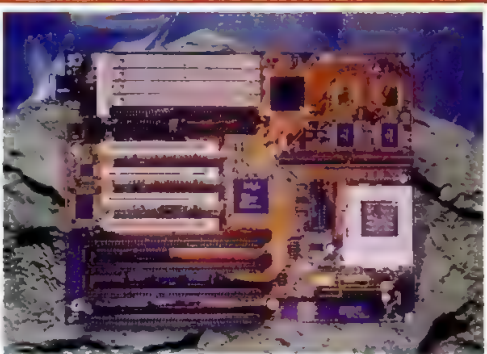
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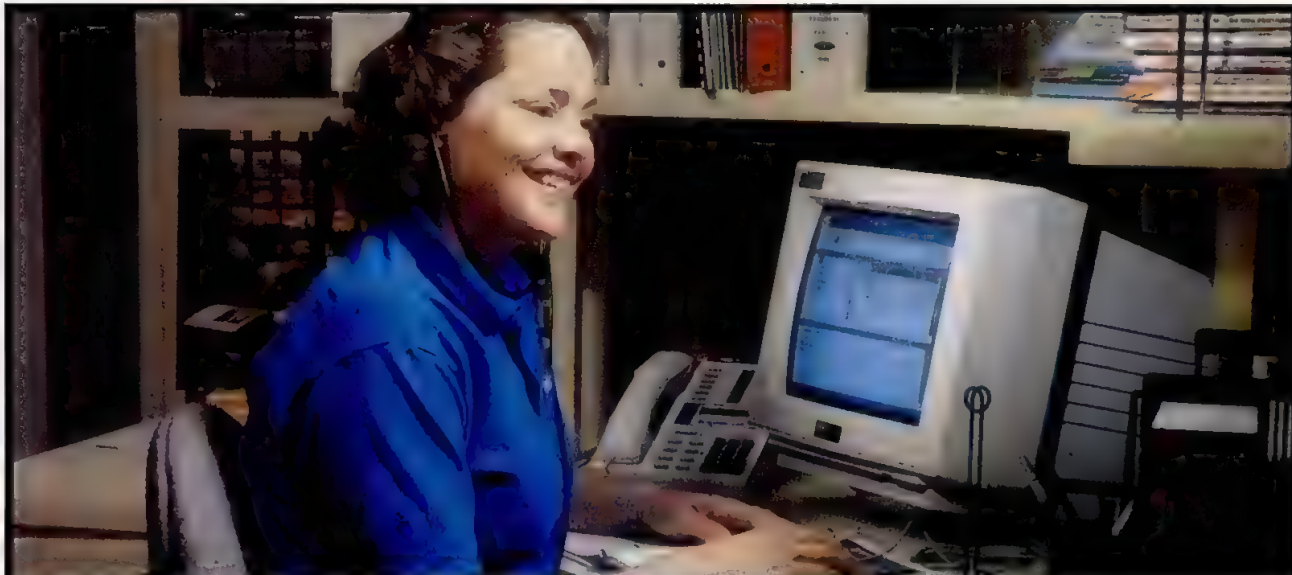
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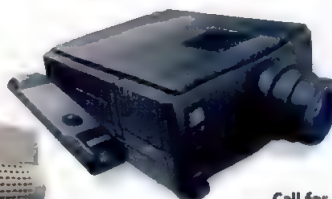
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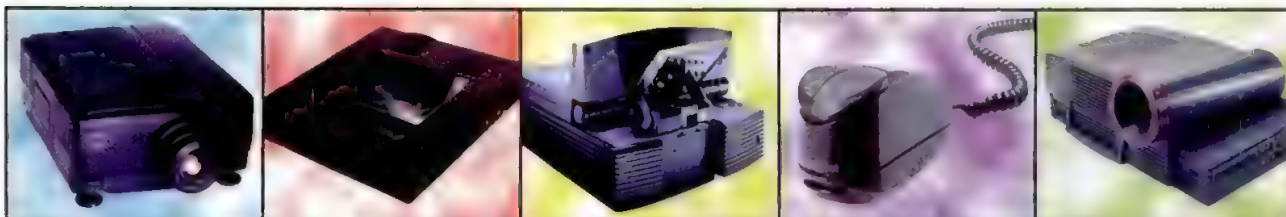
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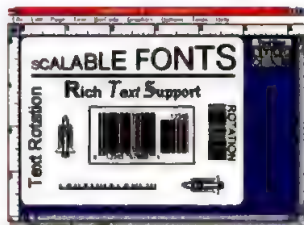
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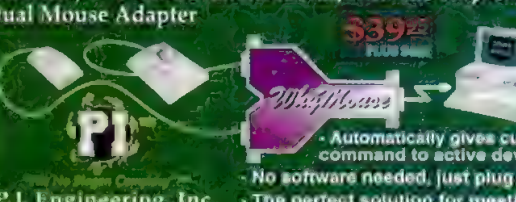
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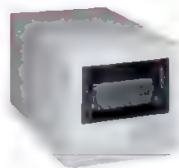
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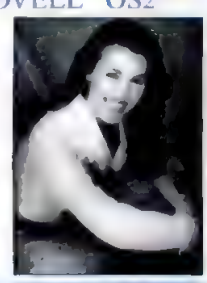
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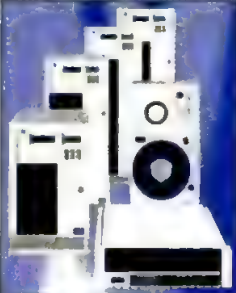
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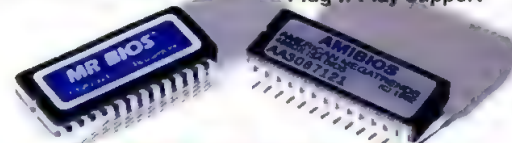
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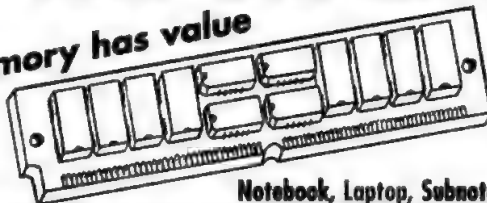
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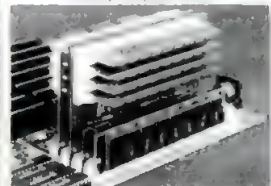
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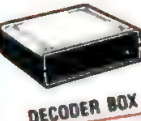
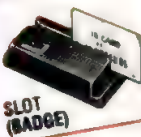
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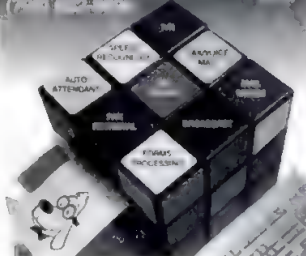
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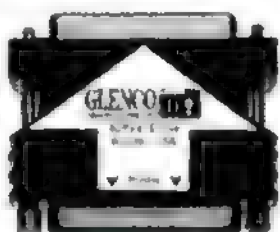
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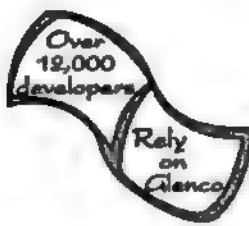
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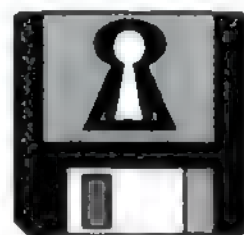
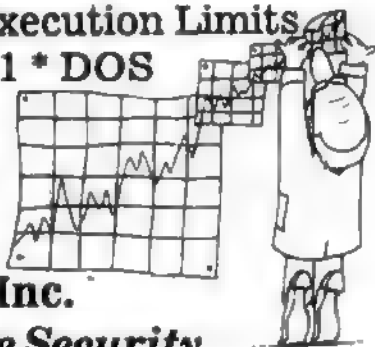
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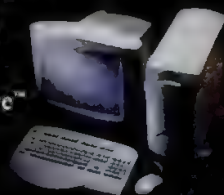
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At Home

A SPECIAL REPORT ON PRODUCTS FOR THE PERSONAL SIDE OF COMPUTING



3-D HOME-DESIGN SOFTWARE

Do-It-Yourself Design

Building or remodeling your home can be an agonizing process. Before any real building begins, plans are often drafted, scrapped, drafted again, revised, and tweaked many times over as you and your architect search for that one perfect design for your dream house. But if you could experiment with design concepts on your PC, then present those ideas to an architect, you just might save yourself some time and money. At least, that's the idea behind 3-D home-design software.

These five packages are basically low-end computer-aided design (CAD) tools, tailored

for floor plans and other aspects of home design. They let you draft a virtual home in a flat, 2-D plan, then give you a rough idea of how it will look in real life. You can also use these applications to place numerous objects, such as doors, windows, stairs, and many different types of furniture, in your design using a variety of 3-D clip

art. The better packages will offer some advice on how to produce a better design—even provide an estimate of how much your dream house might cost. Also, a really useful 3-D design tool will allow you to save your design in a format (.DXF) that can

IN THIS REVIEW

Home Design 3D 4.0.....	320	3D Home Architect.....	331
FloorPlan PLUS 3D.....	322	Building a Better 3-D	
myHouse for		Home-Design Tool.....	318
Windows 2.0.....	325	Editors' Choice.....	320
Planix Home		The Right Tool	
Designer 3D 2.0.....	326	for the Right Job.....	326

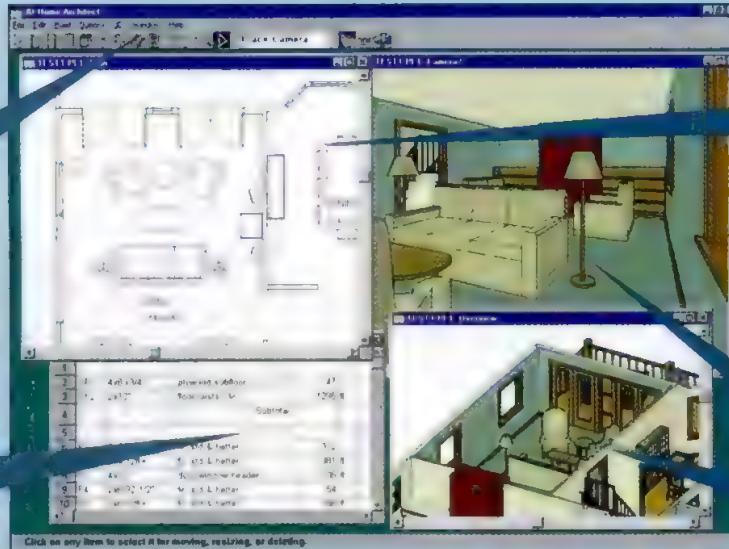
By Michael E. Ryan

Building a Better 3-D Home-Design Tool

All of the products in this roundup could use some improvement. We'll use this screen from 3D Home Architect to illustrate how we would design our own 3-D home-design package.

A good 3-D home-design tool needs an **intuitive** toolbar or menu with clear, easy-to-understand buttons. This one has the standard Windows look, but we prefer the friendlier 3-D Kitchen interface.

Any home-design tool—3-D or not—should provide an **estimate of the cost** your design will incur. Ideally, you should be able to enter real-world costs for each object on the list.



The 2-D design window is pretty basic, but we do like the fact we can leave it open as we view the floor plan in 3-D. Our ideal 2-D design window would include a grid that has **snap-to-grid** placement of objects.

Simultaneous, **multiple 3-D views** are key. 3-D walk-through features are fun, but each one we used was either slow or lacking in detail. The ability to see several static 3-D views of a design is more useful.

be read by more powerful CAD tools, such as Advanced Relational Technologies' Chief Architect and Autodesk's AutoCAD—the tools used by many professional architects. After all, most likely you're going to want to have a professional involved in this process.

In this story, we review five major Windows-based 3-D home-design packages, the prices of which range from around \$15 to \$130. Expert Software's Home Design 3D 4.0 (\$14.95) claims the low end of the price range, while Softdesk Retail Products' Planix Home Designer 3D, Version 2.0 (\$129.00), is perched at the top of the scale. In between, we have IMSI's FloorPlan PLUS 3D (\$69.95), DesignWare's myHouse for Windows, Version 2.0 (\$84.95), and Broderbund Software's 3D Home Architect (\$69.95).

To evaluate these products, we focused on three broad areas, which constitute our Report Card: setup and configuration, features and functions, and usability.

Some of these products required a Herculean effort just to figure out how basic functions, such as wall and window placement, worked.

Setup and configuration is straightforward but crucial, especially in a home software package. The features and functions category is quite broad, taking into account all of the basic capabilities of each package, along with any advanced features that may be offered by each.

The last category, usability, is perhaps the most important.

After all, we evaluated the value of these products in terms of their benefit to home users, not to professional architects. Besides, the word *easy* figures prominently on

quired a Herculean effort just to figure out how basic functions, such as wall and window placement, worked.

We also wish to take each vendor to task for citing a 386-based processor as the minimum requirement to run these packages. Four of the five vendors go on to specify 4MB RAM as a minimum as well. Based on the 3-D rendering performance we saw for each and every package, we're not sure how the vendors can possibly claim such things. In fact, we strongly recommend that you have a Pentium/90 with 8MB at the absolute minimum. Ideally, you'll want a Pentium/133 with 16MB or more.

With practice and the right

each product's packaging, and we wanted to verify the validity of its usage.

Unfortunately, most of the products in the roundup were not easy to use at all. Some re-

Our Contributors: C. JAMES GALLEY III is executive director and NICK STAM is technical director of hardware at PC Magazine Labs. CRAIG ELLISON is system-support manager at PC Magazine. MICHAEL E. RYAN was the associate editor in charge of this story.

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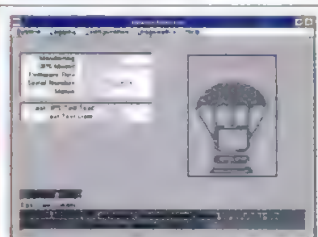
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system, however, we found that each of the packages had at least one outstanding quality. If all five could somehow be merged into a single product, we'd have the perfect 3-D home-design tool.

Expert Software Inc.

Home Design 3D

In the software market, it's not unusual to get exactly what you pay for. But with Home Design 3D, you get more than you'd expect from the product's \$14.95 price tag. Intended for users who want to develop design concepts—as opposed to full-blown architectural blueprints—Home Design 3D is an exceptional value.

The product installs quickly and requires roughly 7MB of hard disk space. Most of this space is taken up by 28 sample floor plans and more than 300 objects, such as tables, chairs, and other furniture. If you don't have Video for Windows already installed, Home Design 3D will install it so that you can view the product's 28 video clips, each of which depicts internal and external views of one of the sample plans.

One of the first things we noticed about Home Design 3D was its lack of printed documentation. Installation instructions are printed on the liner notes inside the CD-ROM jewel case, but all other instructions, along with a 16-screen tutorial, are included in a Windows help file. This file is indexed but does not offer context-sensitive help.

3D Home Architect

Each of these five 3-D home-design packages is a powerful tool, and each has at least one outstanding feature. But when it comes to providing the best mix of power, features, and ease-of-use, one product stands ahead of the rest—by a wide margin.

Broderbund's 3D Home Architect is the winner of our Editors' Choice award.

In a product category that is rife with complex, confusing, and often intimidating tools, 3D Home Architect is well designed, easy to set up, and easy to use. This mature, well-rounded product is far from perfect, but it offers a set of flexible and powerful home-design tools without overwhelming users with quirky CAD nuances. 3D Home Architect also provides most of the basic features necessary to produce a solid home design, along with some advanced fea-

tures—including excellent instructional video clips and articles.

We also give a qualified honorable mention to Expert Software's Home Design 3D 4.0. Though it offers fewer features and less raw rendering power than the other packages, for its \$14.95 price, this product is a steal. In fact, Home Design 3D is the perfect choice for users who want to experiment with some design and remodeling concepts, but who are unwilling to invest the \$70 or more required by one of the other, more powerful packages.



We had to call technical support for help with a few features that were not described in the help file.

Home Design 3D's interface has an "always-on-top" toolbar that provides easy access to the ten basic tools that make up the heart of this product. The wall tool lets you create walls that will automatically link with other, adjoining walls to

suit your tastes, then place a new window in the design. This can be a pain, especially for minor adjustments.

The rotate tool allows you to spin objects in your design by 45-degree increments. If you need to rotate objects at other increments, you can do

so by holding the Shift key while using the rotate tool—but this feature is not mentioned in the help file (we found it by accident).

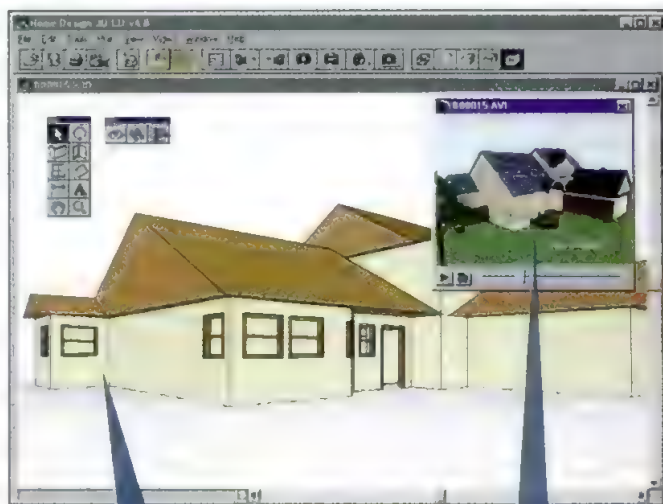
The dimensioning tool lets you add dimension lines to your design, and the text tool lets you annotate your draw-



Home Design 3D

- Setup and configuration **B**
- Features and functions **B**
- Usability **C**

form corners. The door, window, and roof tools are available to let you place each respective object type. The preferences for each type of object, however, must be set before you place each in your floor plan. For example, you can't change a window style in your design once you've placed it. You must first delete the old window, reset the window preferences to



Home Design 3D includes videos of its sample designs. Most are much more impressive than the actual plans, however, and—call us cynical—we somehow suspect that this product was not used to render the animations.



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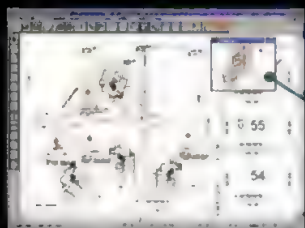
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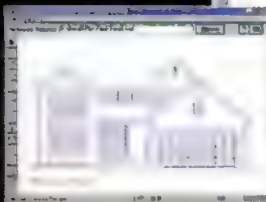


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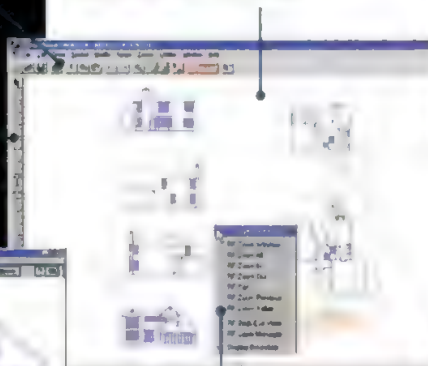


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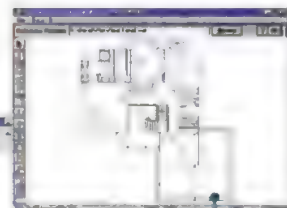


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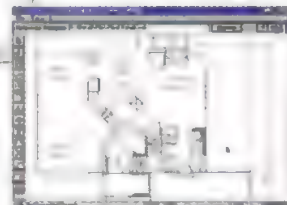
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3-D HOME-DESIGN SOFTWARE

Reading the Report Cards

A good 3-D home-design package should be both powerful and intuitive. We graded each of these five Windows-based design packages in three broad categories. The grades we used and their meanings are as follows: A, excellent; B, above average; C, average; D, below average; E, failing.

An average score for **setup and configuration** indicates that the product was easy to install and required little hard disk space. Higher scores were given for multiple installation options or other helpful features, such as Autoplay support under Windows 95. The highest scores were given only to products that offered all of these plus an uninstall option—no matter how easily the product installed.

ing. The text annotations, unfortunately, cannot be rotated and always run horizontally across a design.

The last three tools on the toolbar are for 3-D viewing. The eyeball tool lets you see a 360-degree view around any spot you select in the design. A walking tool lets you wander through the design, and the helicopter tool gives you an aerial view of the design. The 3-D views are rendered quickly, but they are not very detailed. Also, it took us a while to get the hang of maneuvering our way through each of the 3-D views.

Home Design 3D lacks a few features that other packages provide. These include the ability to generate a bill of materials from your design, automatic dimensioning of walls and other design elements, and the ability to include curved surfaces and arches in designs (the result of which is a boxy look for most designs). Home Design 3D also utilizes a proprietary file format that prevents you from importing or exporting your designs for use with other packages.

Still, Home Design 3D provides a lot of features and power for an exceptionally low price.—*Craig Ellison*
Home Design 3D 4.0. List price: \$14.95. Expert Software Inc., Coral Gables, FL; 800-759-2562, 305-567-9990; fax, 305-448-2074; <http://www.expert-software.com>. Circle 500 on reader service card.

IMSI

FloorPlan PLUS 3D

The best term to sum up FloorPlan PLUS 3D is *mixed bag*. This package offers several powerful features, but the unimpressive 3-D viewing modes and nonintuitive design editing hamper an otherwise impressive offering.

FloorPlan PLUS provides an assortment of tools to create and edit home designs. The main program allows you to create your plan in 2-D. Two other separate applets—3D Viewer and 3D Roof Editor—complete the set. Using these three tools together, one can create a structure of up to 20 floors and 13 layers.

IMSI provides both CD

Our broadest but most important category encompassed **features and functions**. Here, average scores indicate that the product offered all the basic design features. These include the ability to draw walls, windows, doors, and other common elements in a multiroom design, as well as the ability to render the design in 3-D. Higher scores indicate more impressive 3-D rendering, plus additional features such as multistory designs and the ability to generate a bill of materials.

Finally, we looked closely at each product's **usability**.

Average scores were given for an understandable interface that provided a basic menu or toolbar of the most common commands. Higher scores were given for a useful and relevant Help system, intuitive design processes, and well-designed interfaces.

and floppy disks for installation, which will be convenient for some users. Installation is straightforward, with little input required from the user. During the process, Adobe Acrobat Reader is installed, but we were unable to determine which module used this software.

It took us a few minutes to get used to the product's interface and features. The basic feel of the package is more like that of a high-end CAD tool than a home-user Windows application. For example, to draw a wall, you click the wall icon, click once on the drawing area to start the wall, move the mouse to the desired length, and click again to finish. Also, when you move a wall, FloorPlan PLUS does not maintain that wall's connections to adjoining walls.

Once you do get the walls in place, it's time to fill them

with windows, doors, and furniture, and FloorPlan PLUS includes tons of objects for this purpose. You select most objects by clicking the appropriate button on the toolbar and then selecting the desired item via a pull-down list. Actually, placing the object can be tricky, as multiple objects can overlap.

You can view your design in 3-D by clicking on the 3-D button. As with most other packages, you place a camera in the design and point it toward what you wish to view. You can limit the view to the current floor and only the visible layers, or show all floors and layers. After you decide on these viewing options, the 3D Viewing applet quickly generates a wireframe rendition of your plan.

To view the 3-D design in more detail, you can choose from four shading options: flat, shaded, flat with outlines, and shaded with outlines. Another view option—"hidden lines removed"—is available through the shading options menu. Even at the most detailed setting, however, the rendered

designs can be disappointing. Most objects look fine, but some—such as doors and windows, in particular—are severely lacking in detail. When you want to walk through your 3-D design, the 3D Viewer applet launches to generate a 3-D view of the floor plan.

As for the last module, 3D Roof Editor, we feel that only the truly motivated will enjoy it. While IMSI earns kudos for including a roof-construction tool in the first place, the tool could



Floor Plan PLUS 3D

Setup and configuration	B
Features and functions	B
Usability	C

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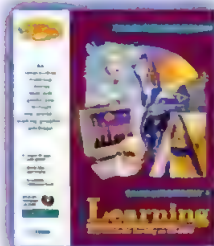
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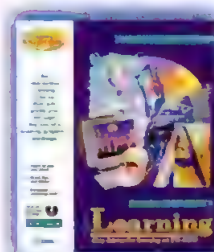
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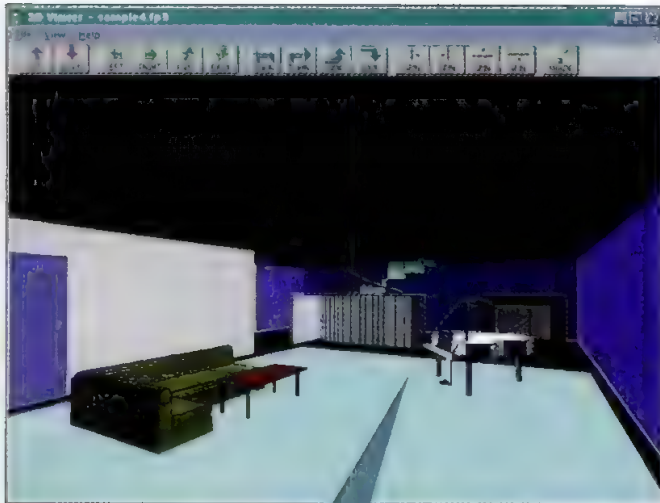
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3-D Home-Design Software



FloorPlan PLUS 3D is a fairly powerful design package, but as this scene indicates, its 3D views leave a bit to be desired—for example, you can even see through the piano.

be simplified quite a bit. Perhaps in recognition of this, the manual suggests that users experiment with some of the prebuilt roof options to gain familiarity before attempting to create a roof from scratch.

Problems aside, **FloorPlan PLUS 3D** would be even more impressive.—*C. James Galley III*
FloorPlan PLUS 3D. List price: \$69.95. IMSI, San Rafael, CA; 800-833-4674, 415-257-3000; fax, 415-257-3565; <http://www.imsisoft.com>. *Circle 501 on reader service card.*

DesignWare Inc.

myHouse for Windows

On the one hand, **myHouse for Windows**, Version 2.0, has a lot going for it: powerful CAD-like features, extensive object libraries, and numerous sample plans. On the other hand, it can be complicated and frustrating to use.

Installation of **myHouse** is a simple, one-step affair and requires roughly 12MB of hard disk space.

The package comes with all the tools you'll need to design or remodel basic floor plans and build complex multistory homes. **myHouse** lets you work with standard building elements such as walls, windows, doors, and stairs, but it also offers such features as roofs, slabs (for floors and ceilings), and columns.

When you select an element type, a secondary toolbar opens to reveal extended options. For example, when you select a wall, the secondary options include single walls, rectangular walls, and curved walls. For most building elements, the secondary toolbar also contains a library icon that provides access to a number of objects. Many objects, such as chairs and other types of furniture, can be placed anywhere in the design—and we mean *anywhere*: We were able to put a staircase on top of a doorway and a car in our living room. Other objects, such as doors and windows, can be placed

only in specific locations.

myHouse's many other features include flexible text size and placement, dimensioning and zoom tools, export—but not import—of .DXF files for use with other design packages, and bill-of-materials generation.

But **myHouse** is not the easiest

of products to use. Its CAD-like drawing tools are a bit nonintuitive. For example, **myHouse** uses the same awkward wall-placement method as **FloorPlan PLUS 3D**: Click to start, drag to the desired endpoint, and click again to anchor. Doors, windows, and other objects also require extra mouse clicks or keystrokes to place and anchor them. We liked the product's Cartesian coordinate system, which offers relative and absolute x,y cursor positioning for precise placement of walls and other objects. This fea-



myHouse for Windows 2.0

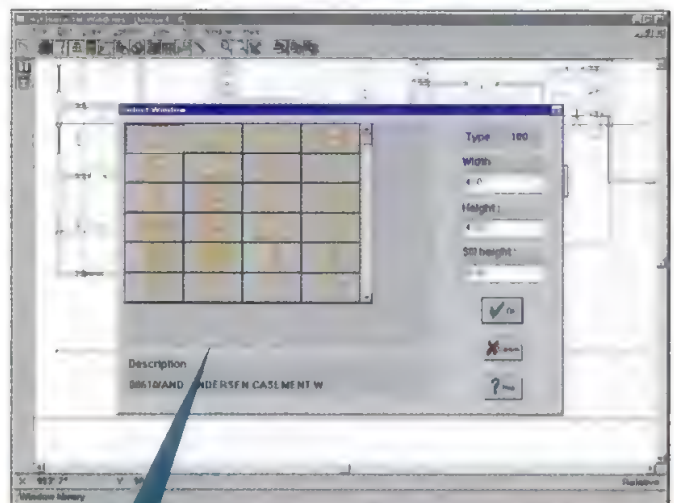
Setup and configuration	B
Features and functions	A
Usability	C

ture, though, also contributes to the complexity of **myHouse**.

For 3-D viewing, you begin with a wireframe view, from which you can render solid-modeled or hidden-line-removed views. Although both options produce good results, the rendering performance is very

slow on anything less than a Pentium/90. Camera-placement options are very flexible in **myHouse**, but they must be used in wireframe mode. Once rendered, the 3-D objects have little architectural detail compared with those rendered with **3D Home Architect** and some other packages.

You can't walk through your 3-D design in **myHouse**, but you can generate animation using the 3D Movie Maker option. 3D Movie Maker permits you to set up a camera path through your design and generate a video



Although **myHouse for Windows** includes many complicated features, some of the more basic processes—like selecting a window—are well implemented and intuitive.

tour of exterior and interior views.

The DreamScene feature allows you to use bitmap images as backgrounds for your design. While this feature is fun, it offers no real value.

Documentation and on-line help are only fair, and no video tutorials are included. In addition, myHouse does not save changes to the program defaults during a session; any changes that you make must be entered again

the next time you use the package.

So although myHouse for Windows is a powerful package with some outstanding features, it suffers from a few annoying quirks and can be difficult to use. —Nick Stam

myHouse for Windows, Version 2.0. List price: \$84.95. DesignWare Inc., Watertown, MA; 800-536-2596, 617-924-6715; fax, 617-924-1699. *Circle 502 on reader service card.*

Softdesk Retail Products

Planix Home Designer 3D

Planix Home Designer 3D, Version 2.0, is a solid product with plenty of features that will appeal to the seasoned do-it-yourselfer. On the surface, it boasts more tools, objects, and views than many of the other packages reviewed here. That beauty, however, will seem only skin-

deep to many inexperienced users. With more comprehensive roof and multifloor viewing capabilities, and a host of usability improvements, Home Designer would be a much stronger contender.

The package, which includes both CD-ROM and floppy versions, was easy to install. To help you get started, the product includes 11 tutorial plans and 500 professional plans (on the CD).

Home Designer's shell build

The Right Tool for the Right Job

By Michael E. Ryan

So maybe you don't need to remodel your entire home, but your kitchen needs a facelift in the worst way. Or maybe you just need to rethink the landscaping around your dream house. If so, one of these two products from Books That Work may be perfect for you.

With **3D Kitchen** (\$79.95), you can create amazingly detailed 3-D views of your ideal kitchen, customizing everything from floor and ceiling types and room dimensions to the style of appliances you want to use. 3D Kitchen operates very much like the home-design packages in this story but is intended to produce kitchen-only designs. Actually, you can create any kind of room you want with 3D Kitchen—you just can't design an entire home.

3D Kitchen is a product that was clearly designed for the home user. The interface is outstanding, with large, easy-to-understand buttons and menus and an appealing wood grain motif. You'll find creating a new design or editing a sample one fairly easy. Inserting a wall, for example, is simple: Although 3D Kitchen uses the same click-drag-click method we disliked in many of the home-design packages, this product will automatically place a default-size wall for you if you pause for a few seconds after selecting the starting point.

The same process works for placing the abundant supply of various objects provided by 3D Kitchen. Chairs, cabinets, tables, and appliances fill the product's object libraries. Other items, such as plants and even people, can help give you a better idea of what your kitchen will really look like.

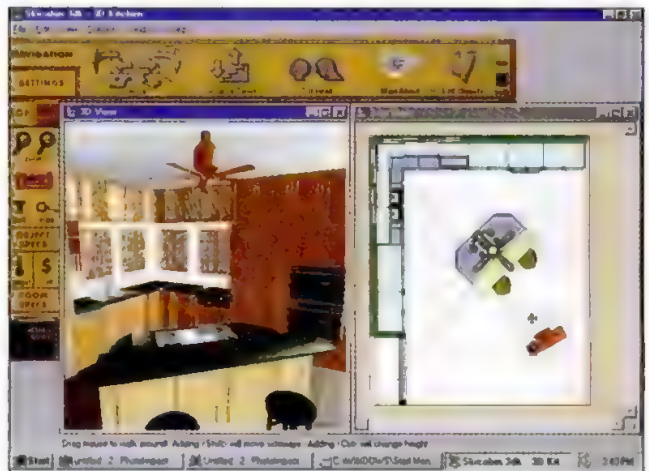
The product's 3-D views are far and away the best of any product in this story. They may take a few minutes to render on some machines (again, we recommend a Pentium/90 or better), but the results are astounding. Rather than flat polygons and wire frames, you see detailed objects and surfaces, complete with textures.

Moving outdoors from the kitchen, we came upon **3D Landscape**, a package that offers the same top-quality features and ease-of-use as 3D Kitchen, but with a different set

of design tools and objects. For example, 3D Landscape lets you choose what types of trees, plants, and shrubs to place in and around your lawn. You can also place objects such as fountains, walls, walkways, and even doghouses in your design. You can also change the slope of the ground.

The interface and graphics are good, though not quite as polished as those in 3D Kitchen. Also, the 3-D rendering takes quite a bit longer in 3D Landscape.

Other great features include a Shadow Caster, which lets you see how shadows will vary in your design over the course of a day or a year, and Growth Over Time, which gives you an



3D Kitchen is a well-rounded, intuitive package with plenty of features and excellent graphical detail.

idea of how big those trees in the front yard are going to grow.

Both products provide a wealth of tips and hints, as well as an often-sobering estimate of costs for your projects.

3D Kitchen. List price: \$79.95. **3D Landscape.** List price: \$89.95. Books That Work, Palo Alto, CA; 800-242-4546, 415-326-4280; fax, 415-812-9700; <http://www.btw.com>. *Circle 505 on reader service card.*



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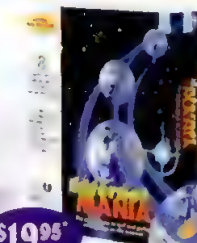
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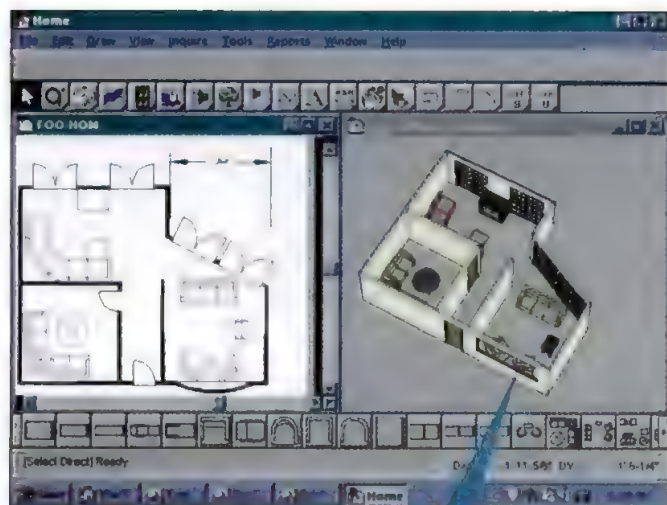
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AT HOME
3-D Home-Design Software



Planix Home Designer 3D is a very powerful and easy-to-use home design program. It includes some of the most advanced features, including some of the most powerful rendering engines in the product renders windows and

feature will appeal to users planning to remodel their existing homes (as opposed to those planning to design new ones). With this feature, you can take the existing measurements of your house and easily attach a series of exterior walls. You simply choose the closest predefined house shell and enter in your house's dimensions.

The next step, adding external and internal walls, is also simple—in theory. As do FloorPlan PLUS 3D and my-House for Windows, Home Designer uses an awkward click-move-click method for drawing walls. And the package makes editing walls a bit of a chore: If you move one endpoint of the wall, it's nearly impossible to straighten the wall again. (Creating a straight wall in reality is difficult enough; you'd think it would be easier with a program, right?)

Adding walls, doors, and ob-

jects also proves to be difficult at first. Though the object palette shows all related objects in one, easy-to-use box, placement of these objects can be cumbersome. For example, to place a window you first select a window type, then click on the wall in which you want the window. You then stretch a line in the direction that you want the window to be placed and click again. Though this and other features are customizable, the defaults are most unfriendly.

Home Designer has an impressive array of 3-D viewing features. Five different vantage points are offered via a menu bar. One shows the entire house, the other shows a top view, and the remaining

three each let you select a portion of the design and view it from a top, bird's-eye, or standing view. The views, however, are limited in detail. Windows, for example, are



Planix Home Design 3D	
Setup and configuration	B
Features and functions	A
Usability	C



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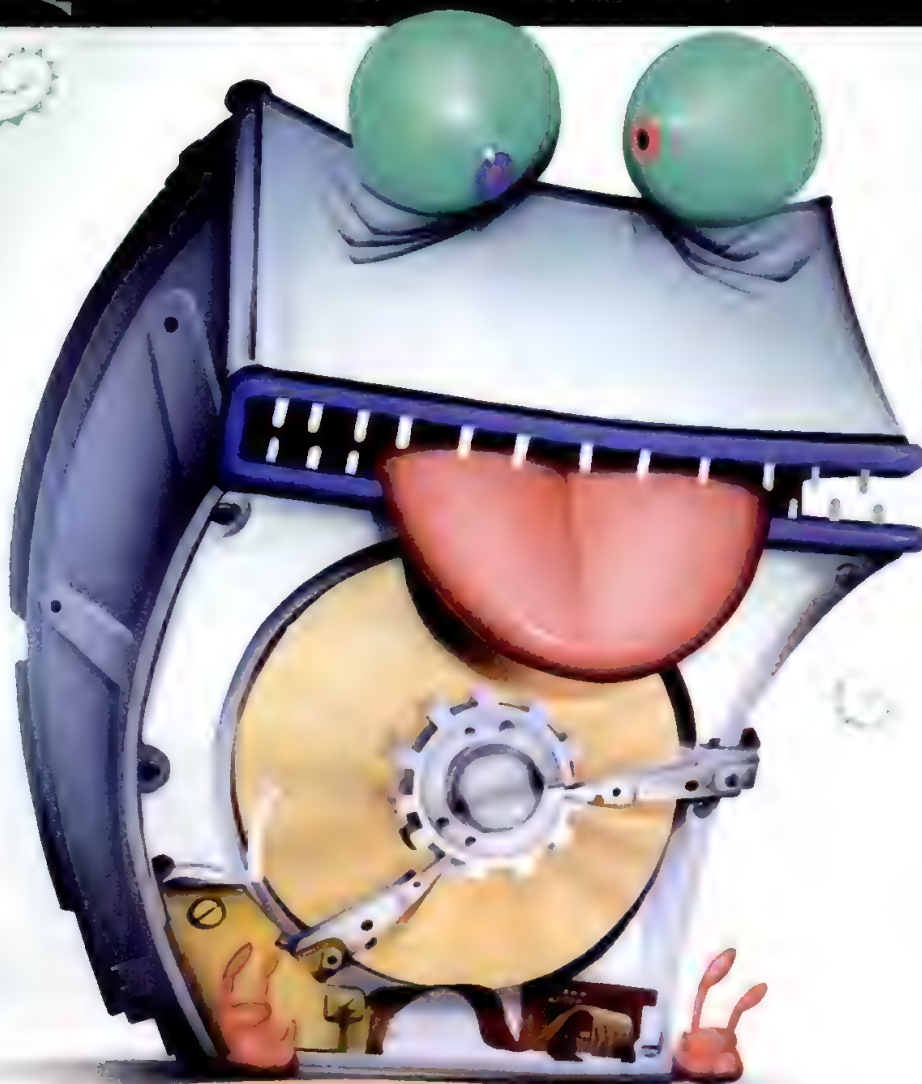
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3-D Home-Design Software

rendered as holes in the wall with no visible detail. Also, the package does not provide roof-line or multistory views.

Other design tools, including phone-system, alarm-system, audio/video-system, and computer-network tools, are interesting additions. Best of all, each of these systems is thoroughly explained in the manual. Especially interesting is the lawn-irrigation section, where every design phase is detailed in clear, concise terms. If any of this information could be incorporated into a Wizard routine, Home Designer would be a much-improved tool.

Planix Home Designer 3D isn't for everybody. But if you yearn for a product that has all the features you need to design a truly complete plan—and you don't mind a steep learning curve—it's definitely worth a look.—CJG

Planix Home Designer 3D, Version 2.0. List price: \$129. Softdesk Retail Products, Kansas City, MO; 800-231-8574, 816-891-1040; fax, 816-891-8018. <http://www.softdesk.com>. Circle 503 on reader service card.

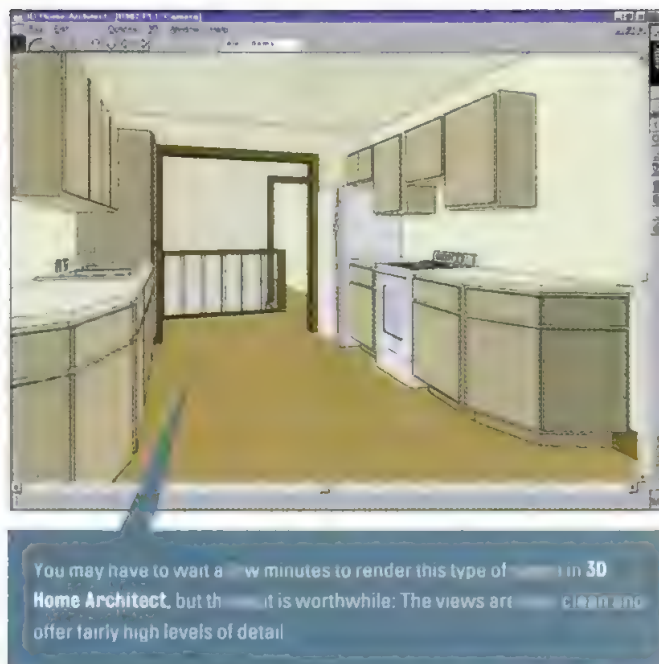
Broderbund Software Inc.

3D Home Architect



Broderbund Software's popular 3D Home Architect is a powerful product with excellent instructional features. It's not perfect, but it stands out from the crowd in this roundup because of its excellent mix of power and intuitive design features.

Unlike the other packages here, 3D Home Architect lets you click and drag objects into your design, allowing for simple drawing, placement, and manipulation of designs. Mul-



ti-floor designs, bill-of-materials generation, extensive object libraries, automatic placement and connection of electrical outlets, and simple 3-D camera operation are some of the product's key features. The abilities to alter object-sizing and place building elements from both 2-D and 3-D views make visualization and design modifications a snap. We especially liked the SmartParts and PlanCheck features that assist proper object placement and structural design.

We tested the CD-ROM version of 3D Home Architect (the product is available separately on floppy disk). The CD includes instructional text, as well as a collection of more than 150 sample home plans. It also includes more than 50 instructional videos featuring Gerry Connell, host of The Learning Channel's "The Home Pro," and 120 articles from *American HomeStyles* magazine. These resources alone are arguably worth the price of the package.

3D Home Architect provides easy-to-use menus and

icons for selecting windows, doors, walls, cabinets, fixtures, furniture, stairs, and electrical objects. As with other design packages, you first pick a broad object category, then narrow your selection through subsequent menus.

You can draw walls at just about any angle, and the program will automatically connect walls that are close enough together.

Generally, you can place objects anywhere in your floor plan, but the SmartParts feature helps make sure that you don't place objects where they don't belong (like putting a car in

your living room). Nevertheless, we were able to place a refrigerator 3 feet up a wall and a staircase on top of the refrigerator. The PlanCheck feature highlights design problems and potential improvements to the design, but its repetitive tips and suggestions

can be annoying.

Three-dimensional viewing is one of 3D Home Architect's strengths. As you work on your 2-D design, you can continually switch to 3-D viewing mode to see what it will actually look like. The graphics aren't exactly lifelike, but they are good enough to give you a clear picture of the room with all design elements in proper perspective. Rendering is pretty slow, however.

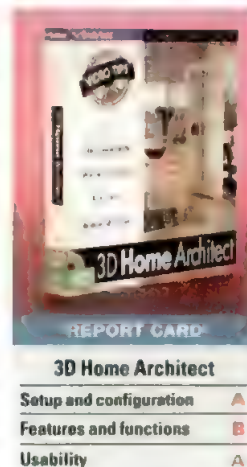
As with most of the other packages in this roundup, you place a camera and select a viewing angle to generate a 3-D view. With 3D Home Architect, you cannot move through your 3-D design, but you can generate multiple, simultaneous 3-D views of the same floor plan. This allows you to see the floor plan from a variety of angles.

3D Home Architect does lack a few features that would make it a truly exceptional product. For example, there is no support for roof or ceiling design, the vertical angles of 3-D cameras cannot be modified, and no snap-to-grid features exist in the 2-D mode, because there is no grid to assist in precision drawing.

Yet, for the best mix of features, ease-of-use, and affordability, 3D Home Architect is the clear favorite in

this group.—NS □

3D Home Architect. List price: CD-ROM, \$69.95; disks, \$59.95. Broderbund Software Inc., Novato, CA; 800-521-6263, 415-382-4700; fax, 415-382-4582; <http://www.broderbund.com>. Circle 504 on reader service card.





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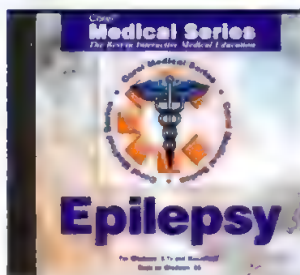
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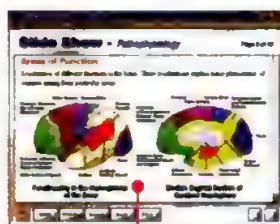
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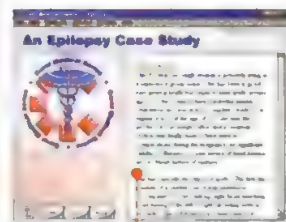
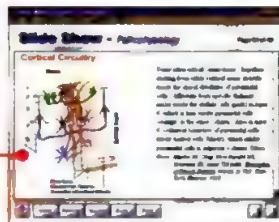


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Going Somewhere?

Ah, summer. What better time could there be to pack up the car with family and friends and head off on a vacation? Thanks to these three trip-planning packages, you can figure out where to go, how to get there, and what cool spots await you along your path.

Automap Road Atlas 4.0

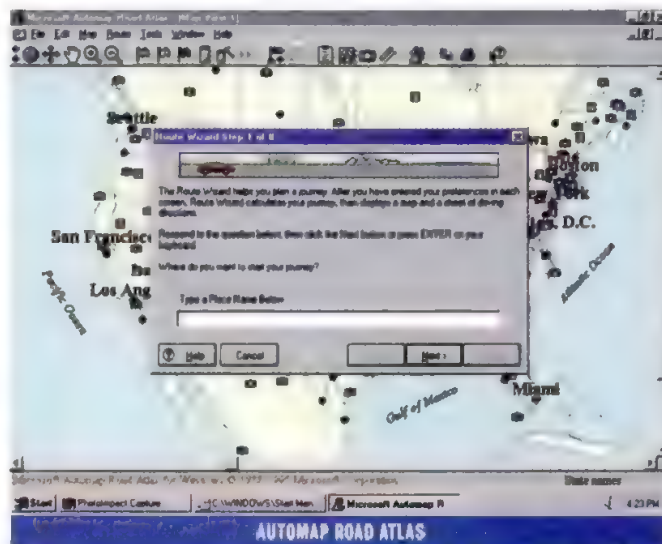
Microsoft Corp., 800-426-9400, 206-882-8080; <http://www.microsoft.com/mshome>. Circle 496 on reader service card.

★★★★★ \$29.95

Microsoft's Automap Road Atlas 4.0 is an easy-to-tailor, detail-oriented, multimedia road-trip planner.

The main map screen, which displays the continental United States, is fun to explore. By double-clicking on the many camera and *i* icons, you pull up clippings from the database of 1,600 articles and 1,100 color photographs.

The Route Wizard's eight windows take you through the planning process—covering the most obvious details (where you want to start and where you want go) to the more fastidious (how much



fuel is in your tank at the start of your trip, tank capacity, and city and highway mileage). The Wizard can even figure in 25 stopovers along the way.

The route-preference window is the strongest feature of the package. Besides the standard options for quickest and shortest routes, it offers a highly programmable third option called "roads I prefer"; this option lets you indicate preferences for interstates, divided highways, or other roads. A few slight adjustments here can open up sneaky back routes (thanks to the program's extensive database). The program will also calculate three alternative routes in addition to the ones listed above.

Automap is full of helpful touches: The "sights along the way" window, for example, includes rest areas, airports,

parks, and attractions, taking into account, of course, how far away you're willing to stray from your route. The moun-

tain button indicates elevations along your route, which can be helpful if you plan to tow a Ski Nautique to your favorite body of water and want to avoid steep slopes.

When you finish planning your trip, you can print the map and directions. The printout is explicit and readable, listing times, distances, instructions, road names, and directions.

Microsoft also offers a street-map CD-ROM that you can use in conjunction with Automap (if both are installed in the same directory) called Automap Streets (\$54.95).

The software requires a 386-based PC or better, 4MB of RAM, and 3.5MB of hard disk space (8MB is recommended).—Mary E. Behr

Road Trips

TravRoute Software, 800-297-8728, 609-252-8160; fax, 609-252-8166; <http://www.travroute.com>. Circle 497 on reader service card.

★★★★★ \$29.95

TravRoute Software's Road Trips doesn't have a big name behind it like the other two products in this review, but this is an impressive title that provides sufficient customization features and a straightforward approach to trip planning. TravRoute Software has been supplying maps and driving information to auto clubs in the United States since 1990; Road Trips is the company's first venture into software.

The trip planning is divided into three screens. On the first, you can select your trip's start and end points as well as your preferred route type (quickest, shortest, or preferred). The



second screen is for choosing stopovers, of which the product supports 15. The last is for choosing average speeds. This is one of the most detailed windows, as it lets you choose speeds of up to 99 mph on a

IN AFTER HOURS

Going Somewhere?

Automap Road Atlas 4.0.....335

Road Trips.....335

Rand McNally TripMaker
1996 Edition.....336

Muppet Mayhem

The Muppet CD-ROM:
Muppets Inside.....336

variety of road types: multilane toll-free roads, toll roads, divided highways, urban highways, and local roads. You can also specify your preference for each type of road.

The program prints beautiful maps along with a complete itinerary that provides a ton of information, including road names, directions, tolls, miles, intersections, states, drive times, and total times. You can also customize your itinerary with different fonts—to jazz up a party invitation, for example.

This program does not bring any multimedia aspects, such as photos of tourist attractions or audio walk-throughs of the programmable windows, to your planning experience. Also, the program lacks accommodation and airline information, although the company's Web site offers lists of hotels, airlines, and popular destinations, and it also provides weather updates.

The software requires a 486-based PC or better, 4MB of RAM, 4MB of hard disk space, a 4X CD-ROM drive, and Windows 95 or 3.1.

—MEB

Rand McNally TripMaker 1996 Edition

Rand McNally New Media; 800-671-5006 (ext. 402), 716-871-7704. Circle 498 on reader service card.

★★★★ (9.95)

Rand McNally packages its electronic trip planner with a tabloid-size atlas as a souvenir of the age you've just left behind. The Rand McNally TripMaker 1996 Edition offers myriad benefits over its pulp-based predecessor.

TripMaker has three dis-

tinct options: Explorer Guide lets you look at a region or city, while Trip Guide and Quick Trip offer two levels of detail for trip planning.

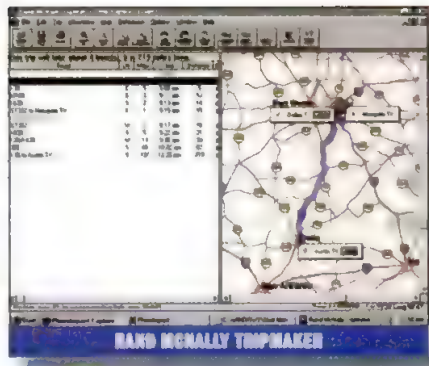
The Explorer Guide contains hundreds of attractions (supplemented by 1,000 photos) covering topics like our heritage, the beach, outdoor adventuring, hotels, and fun for kids. You can view the categories you select as a slide show.

The audio-enhanced Trip Guide has six windows, covering the trip's starting and ending points, stopovers, time preferences, trip dates, and route preferences. The latter offers quickest, shortest, and scenic options, but with a twist: You can select a different option for each leg of your trip.

Quick Trip takes the most significant of Trip Guide's questions and condenses them into one window. There's also a Trip Tutor, which will walk you through any areas of the program you find confusing.

Like Microsoft, Rand McNally also offers a street-level map package, the StreetFinder 1996 Edition (\$49.95). That package offers a direct link to TripMaker if both are installed in the same directory.

TripMaker requires a 486-based PC or better, 4MB of RAM (8MB recommended), a 2X CD-ROM drive, and Windows 95 or Windows 3.1. You choose from two installation options: 7MB or 15MB.—MEB



Muppet Mayhem

The Muppet CD-ROM: Muppets Inside

Starwave Corp.; 800-457-8646; <http://www.starwave.com>. Circle 499 on reader service card.

★★★★ (9.95)

Under most circumstances, molecular digitization is no laughing matter—lives are lost; clothes are wrinkled. But when Jim Henson's lovable Muppets are accidentally digitized and trapped inside your PC at the beginning of The Muppet CD-ROM: Muppets Inside, you and your kids will end up in stitches. This wonderful collection of games will keep you laughing through hours of challenging gameplay and entertainment as you set out to rescue Kermit, Fozzie Bear, and the rest of the Muppet crew.

The adventure begins as soon as you load the CD and choose a Muppet icon for yourself. The first time you play the game, you'll be treated to an opening number worthy of Broadway, with singing, dancing, and mishaps reminiscent of TV's original "Muppet Show."

Once the introduction is over, the games begin. There are seven types of games in all, each of which features your favorite Muppets, new and old alike. For example, the venerable Fozzie Bear stars in "A Wocka on the Wild Side," a Missile Command take-off in

which Fozzie must dodge audience-launched rotten fruit and shoes. To assist Fozzie in his attempt to cross the stage without getting hit or falling into a booby trap, you shoot missiles at the offending projectiles.

Another game features Clifford, host of the new "Muppets Tonight," in "Scope That Song," a most unusual variation of "Name That Tune." Not to be outdone, the Swedish chef and a bevy of angry groceries star in "Kitchens of Doom," the Muppetized version of a fairly popular action game. And don't forget the forever cerebral Kermit, who hosts "Trivial but True," a surprisingly challenging Muppet take on "Hollywood Squares."

To win the overall game, you need to win each of these



minigames and collect the Muppets on your DataBus for safe passage out of your PC. As you follow the Bit Map home, you can pick up floating debris such as fruit or fish (to spice up your dashboard) and listen to hilarious sound bytes on the radio.

This CD-ROM is sure to please current Muppet fans, as well as create many new ones.—Angela Hickman

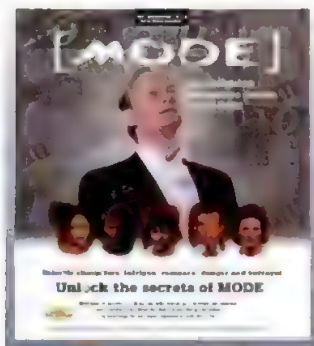
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Advertisers' Index COMPANIES

Reader Service No.	Advertiser	Page
127	3M Company	32-33
226	ADI Systems Inc.	55
235	AMS	42
059	ATI Technologies	35
087	Acer America	90-92
035	Acer America	316
218	Adaptec	330
915	American Power Conversion	NE12-NE13
162	American Power Conversion	319
336	ARLINGTON COMPUTER PRODUCTS	276
012	Austin Direct	246A-D
934	Axis Communications, Inc.	NE9
222	Bull Express	277
292	Caere Corporation	6
*	Canon Japan	188
*	Canon, U.S.A.	84
*	Compaq Computer Corporation	151
*	Compaq Computer Corporation	153
387	CompuLink Research	251
025	CompUSA Direct	264-265
159	COMPUTER DISCOUNT WAREHOUSE	256-257
318	COMPUTER DISCOUNT WAREHOUSE	258-259
360	COMPUTER DISCOUNT WAREHOUSE	260-261
369	Connectix	212
037	Corel Corporation	26-27
339	Corel Corporation	96
314	Corel Corporation	174
358	Corel Corporation	321
042	Corel Corporation	324
322	Corel Corporation	328
011	Corel Corporation	332
041	Corel Corporation	337
095	Creative Labs	204
329	CTX International	74
*	Dell Computer Corporation	C5-C8
*	Dell Computer Corporation	14-15
*	Dell Computer Corporation	68
*	Dell Computer Corporation	120-121
*	Dell Computer Corporation	185
189	Diamond Multimedia Systems	323
931	Digital Equipment Corp.	NE18-NE21
388	Digital Equipment Corp.	58-59
353	Digital Equipment Corp.	70-71
*	Epson America	10-11
014	First Source International	266-267
911	Gandalf Technologies Inc.	NE15

Reader Service No.	Advertiser	Page
*	Gateway 2000	48A-49
391/138	H.Co Memory Upgrades	250
062	HARTFORD COMPUTER GROUP	247
881	Hayes Microcomputer Products	NE22
*	Hewlett Packard	57
*	Hewlett Packard	78-79
*	Hewlett Packard	81
*	Hewlett Packard	165
*	Hewlett Packard	177
143	Hitachi PC Corporation	106-107
*	IBM Corporation	NE7
219	Insight Direct	274-275
*	Intel Corporation	NE10
*	Intel Corporation	72
*	Intel Corporation	191
040	Intergraph Corporation	50
106	Kingston Technology	155
334	Kodak Digital Science Solutions	193
019	L.A. Trade	255
*	Lotus Development Corporation	20-21
006	Luckman Interactive	220
039	MAG InnoVision	16-17
165	Magitronic	249
045	Magix	279
015	Magnavox	86
386	Maxtor Corporation	278
299	McAfee Associates, Inc.	62
283	MEGAHAUS	263
855	Micro Solutions Computer Products	268
*	Micrografx	67
214	MicroHelp Inc.	183
924	Micron Electronics	NE2-NE3
119	Micron Electronics	24-25
164	Micron Electronics	109-114
370	Micron Electronics	115
312	Micron Electronics	131-134
013	Micron Electronics	159-162
*	Microsoft	C2-C4, p1
*	Microsoft	82-83
010	Midwest Computer Works	240-241
154	NEC Technologies	30
157	NEC Technologies	46-47
153	NEC Technologies	142-143
327	NECX	243
036	Newcom	178
*	Novell, Inc.	168-169

Reader Service No.	Advertiser	Page
*	Novell, Inc.	171
232	NuReality	333
892	Octopus Technologies, Inc.	NE25
918	Optical Data Systems	NE16
*	Oracle Corp.	NE5
*	Palm Computing Inc.	13
047	PC Connection	280
080	PC Power & Cooling	88
199	PC Zone	252-253
092	PCs Compleat	269
268	PCs Compleat	270-271
171	Picturatel Corporation	233
196	Plextor	28
038	Powersoft	2-3
148	Primavera Systems	61
056	Pro Direct	273
884	QMS	NE30
309	S.A.G./Storage Solutions	52-53
043	SPSS, Inc.	245
033	Samsung	195
852	Seagate EMS	NE29
271	Seagate Technologies	38
378	Seagate Technologies	206
057	Statsoft	45
023	Sun Microsystems	5
335	Sun Microsystems	222-223
308	Symantec Corporation	18
186	Symantec Corporation	157
316	Symantec Winfax Pro	180
355	Telesys, Inc.	216
246	Texas Instruments	167
305	Texas Instruments	244
379	Toshiba America	98-99
*	Unisys Corporation	64-65
920	US Robotics, Inc.	NE27
051	USA Flex	272
243	Viagrafix	228
*	Visio	210-211
065	VisionTek	227
250	Visual Software	329
085	Winbook	77
163	Xerox Corporation	327
211	Xircom	23
303	ZD Net	338

*No Reader Service Number. Please Call Advertiser For Information.

Advertisers' Index PRODUCTS

Reader Service No.

Company Product Page

ACCELERATOR BOARDS			
059	ATI Technologies	Accelerator Boards	35
189	Diamond Multimedia Systems	Stealth 3D	323
*	Intel Corporation	Tech Series	72

AUDIO BOARDS			
095	Creative Labs	Sound Blaster	204

BACKUP SOFTWARE			
915	American Power Conversion	Matrix	NE12-NE13
162	American Power Conversion	BackUPS ProPNP	319
892	Octopus Technologies, Inc.	Octopus - NT Backup	NE25

BRIDGES/ROUTERS/GATEWAYS			
911	Gandalf Technologies Inc.	XPressConnect LANline 5242i	NE15
918	Optical Data Systems	Switches	NE16

CD-ROM			
934	Axis Communications, Inc.	Axis CD-Server	NE9
232	NuReality	3D Sound Enhancement	333
196	Plexor	8Plex	28

CHIPS/PROCESSORS			
391/138	H Co Memory Upgrades	Memory, PCMCIA	250
*	Intel Corporation	Tech Series	72
106	Kingston Technology	Kingston Memory	155
019	L.A. Trade	Memory	255
065	VisionTek	Memory Chip Upgrades	227

COMMUNICATIONS SOFTWARE			
299	McAfee Associates, Inc.	WebScan	62
186	Symantec Corporation	Peter Norton Group PCAnywhere	157
308	Symantec Corporation	Win 95 - Navigator	18
316	Symantec Winfax Pro	Winfax Pro 7.0	180

COMPUTERS/COMPATIBLES			
035	Acer America	Aspire	316
087	Acer America	Direct	90-92
336	ARLINGTON COMPUTER PRODUCTS	Peripherals	276
012	Austin Direct	Austin Direct Desktops & Notebooks	246A-D
*	Compaq Computer Corporation	LTE 5000	151
*	Compaq Computer Corporation	Prolinea E	153
387	CompuLink Research	Infinity	251
025	CompUSA Direct	Mail Order	264-265
159	COMPUTER DISCOUNT WAREHOUSE	Hardware, Peripherals	256-257
318	COMPUTER DISCOUNT WAREHOUSE	Hardware, Peripherals	258-259
360	COMPUTER DISCOUNT WAREHOUSE	Hardware, Peripherals	260-261
*	Dell Computer Corporation	Dell Desktops and Notebook	C5-C8
*	Dell Computer Corporation	Platinum	120-121
*	Dell Computer Corporation	Dell Dimension	14-15
*	Dell Computer Corporation	Dell Dimension	185
*	Dell Computer Corporation	Dell Dimension XPS 133C	68
388	Digital Equipment Corp.	Digital PCs	58-59
014	First Source International	Memory, Notebooks, Peripherals	266-267
*	Gateway 2000	Desktops & Notebooks	49
062	HARTFORD COMPUTER GROUP	Mail Order	247
*	Hewlett Packard	HP Vectra PCs	78-79
*	Hewlett Packard	HP OmniBook 5000	81
219	Insight Direct	Mail Order	274-275
165	Magitronic	Notebooks	249
045	Magix	PCs	279
164	Micron Electronics	Micron PCs	109-114
370	Micron Electronics	Micron PCs	115
312	Micron Electronics	Micron PCs	131-134
010	Midwest Computer Works	PCs	240-241
327	NECX	Mail Order	243
047	PC Connection	PCs	280
199	PC Zone	Mail Order	252-253
092	PCs Complete	Notebooks	269
268	PCs Complete	Notebooks	270-271
309	S.A.G./Storage Solutions	Pentiums, Servers, Storage Solutions	52-53
379	Toshiba America	Notebooks	98-99
*	Unisys Corporation	Unisys PCs and Servers	64-65
051	USA Flex	PCs	272

DATA BASE MANAGERS			
*	Oracle Corp.	OLAP	NE5
038	Powersoft	Powerbuilder	2-3

DISK BACKUP & TAPE DRIVES			
127	3M Company	3M LS-120	32-33
855	Micro Solutions Computer Products	Tape Backup, CD-ROM, Disk Drive	268

DISPLAYS/MONITORS			
228	ADI Systems Inc.	Monitors	55
329	CTX International	21" Monitor (PR 900)	74
039	MAG InnoVision	MAG InnoVision Monitors	16-17
015	Magnavox	LCD Projectors	86
010	Midwest Computer Works	Monitors	240-241
157	NEC Technologies	Monitors	46-47

EDUCATIONAL SOFTWARE			
358	Corel Corporation	Corel CAD 3D	321
042	Corel Corporation	Learning Series	324
322	Corel Corporation	Internet Combo	328
011	Corel Corporation	Medical Series	332
041	Corel Corporation	Corel MODE	337

ELECTRONIC MAIL			
171	Pictoretal Corporation	Pictoretal PCS	233

ENTERTAINMENT SOFTWARE			
358	Corel Corporation	Corel CAD 3D	321
042	Corel Corporation	Learning Series	324
322	Corel Corporation	Internet Combo	328
011	Corel Corporation	Medical Series	332
041	Corel Corporation	Corel MODE	337

Reader Service No.

Company Product Page

FAX/MODEM			
036	Newcom	Fax/Modem	178

FLOWCHARTING SOFTWARE			
*	Micrograph	ABC Graphics Suite	67
*	Microsoft	Microsoft Office	C2-C4, p1
*	Visio	Visio	210-211

GRAPHICAL INTERFACE			
035	Acer America	Aspire	316
087	Acer America	Direct	90-92

GRAPHICS SOFTWARE			
292	Caere Corporation	OmniPage Pro	6
314	Corel Corporation	Graphics Pack/Draw 6/PrintHouse	174
037	Corel Corporation	Wordperfect 7.0	26-27
339	Corel Corporation	Office Professional	96
040	Intergraph Corporation	Imagineer	50
*	Visio	Visio	210-211
250	Visual Software	Visual Reality 2.0	329

HAND-HELD PC'S			
*	Hewlett Packard	HP OmniBook 5000	81
*	Palm Computing Inc.	Pilot Organizer	13

HARD DRIVES			
219	Insight Direct	Mail Order	274-275
386	Maxtor Corporation	Hard Disks	278
283	MEGAHAUS	Mass Storage	263
327	NECX	Mail Order	243
056	Pro Direct	Mail Order	273

HARDWARE			
012	Austin Direct	Austin Direct Desktops & Notebooks	246A-D
934	Axis Communications, Inc.	Axis CD-Server	NE9
*	Canon, U.S.A.	Canon Color Laser Printers	84
*	Compaq Computer Corporation	LTE 5000	151
*	Compaq Computer Corporation	Prolinea E	153
387	CompuLink Research	Infinity	251
095	Creative Labs	SoundBlaster	204
329	CTX International	21" Monitor (PR 900)	74
*	Dell Computer Corporation	Platinum	120-121
*	Dell Computer Corporation	Dell Dimension	14-15
*	Dell Computer Corporation	Dell Dimension	185
*	Dell Computer Corporation	Dell Dimension XPS 133C	68
189	Diamond Multimedia Systems	Stealth 3D	323
931	Digital Equipment Corp.	Hubs	NE18-NE21
388	Digital Equipment Corp.	Digital PCs	58-59
*	Epson America	Epson Color Ink Jet Printers	10-11
881	Hayes Microcomputer Products	Modems	NE22
*	Hewlett Packard	HP Vectra PCs	78-79
*	Hewlett Packard	HP OmniBook 5000	81
*	IBM Corporation	ATM	NE7
219	Insight Direct	Mail Order	274-275
106	Intel Corporation	Tech Series	72
334	Kingston Technology	Kingston Memory	155
165	Kodak Digital Science Solutions	Kodak DC Camera	193
045	Magitronic	Notebooks	249
015	Magix	PCs	279
283	Magnavox	LCD Projectors	86
327	MEGAHAUS	Mass Storage	263
232	NECX	Mail Order	243
918	NuReality	3D Sound Enhancement	333
*	Optical Data Systems	Switches	NE16
*	Palm Computing Inc.	Pilot Organizer	13
080	PC Power & Cooling	Power Protection/Cooling Devices	88
199	PC Zone	Mail Order	252-253
196	Plexor	8Plex	28
056	Pro Direct	Mail Order	273
884	QMS	1616E	NE30
033	Samsung	Samsung Notebooks	195
305	Texas Instruments	TI Printers	244
*	Unisys Corporation	Unisys PCs and Servers	64-65
065	VisionTek	Memory Chip Upgrades	227

HUBS			
931	Digital Equipment Corp.	Hubs	NE18-NE21
*	Hewlett Packard	HP 10Base - T Hubs	165
918	Optical Data Systems	Switches	NE16

INFORMATION MANAGERS			
038	Powersoft	Powerbuilder	2-3

INTEGRATED SOFTWARE			
314	Corel Corporation	Graphics Pack/Draw 6/PrintHouse	174
037	Corel Corporation	Wordperfect 7.0	26-27
339	Corel Corporation	Office Professional	96
*	Lotus Development Corporation	SmartSuite	20-21

INTERNET			
358	Corel Corporation	Corel CAD 3D	321
042	Corel Corporation	Learning Series	324
322	Corel Corporation	Internet Combo	328
011	Corel Corporation	Medical Series	332
041	Corel Corporation	Corel MODE	337
353	Digital Equipment Corp.	Alta Vista	70-71
006	Luckman Interactive	Web Commander	220
*	Microsoft	Internet	82-83
335	Sun Microsystems	Solaris	222-223
023	Sun Microsystems	Netscape Server	5
303	2D Net	2D Net	338

LABEL/FORM SOFTWARE			
292	Caere Corporation	OmniPage Pro	6

LAPTOP/PORTABLE COMPUTERS			
235	AMS	Notebooks	42
012	Austin Direct	Austin Direct Desktops & Notebooks	246A-D
*	Compaq Computer Corporation	LTE 5000	151
025	CompUSA Direct	Mail Order	264-265

Advertisers' Index PRODUCTS

Reader Service

No.	Company	Product	Page
159	COMPUTER DISCOUNT WAREHOUSE	Laptops	256-257
318	COMPUTER DISCOUNT WAREHOUSE	Laptops	258-259
360	COMPUTER DISCOUNT WAREHOUSE	Laptops	260-261
	Dell Computer Corporation	Dell Desktops and Notebook	C5-C8
	Dell Computer Corporation	Platinum	120-121
014	First Source International	Memory, Notebooks, Peripherals	266-267
	Gateway 2000	Desktops & Notebooks	48A-49
062	HARTFORD COMPUTER GROUP	Mail Order	247
	Hewlett Packard	HP OmniBook 5000	81
165	Magitronic	Notebooks	249
013	Micron Electronics	Micron Notebooks	159-162
119	Micron Electronics	Color Notebooks	24-25
010	Midwest Computer Works	PCs	240-241
153	NEC Technologies	NEC VERSA	142-143
199	PC Zone	Mail Order	252-253
033	Samsung	Samsung Notebooks	195
246	Texas Instruments	TI Notebooks	167
379	Toshiba America	Notebooks	98-99
	Unisys Corporation	Unisys PCs and Servers	64-65
051	USA Flex	Notebooks	272
085	Winbook	Winbook	77

LOCAL AREA NETWORKING

934	Axis Communications, Inc.	Axis CD-Server	NE9
222	Bull Express	Networking Products	277
159	COMPUTER DISCOUNT WAREHOUSE	Networking Products	256-257
318	COMPUTER DISCOUNT WAREHOUSE	Networking Products	258-259
360	COMPUTER DISCOUNT WAREHOUSE	Networking Products	260-261
931	Digital Equipment Corp.	Hubs	NE18-NE21
911	Gandalf Technologies Inc.	XPressConnect LANline 5242i	NE15
062	HARTFORD COMPUTER GROUP	Mail Order	247
	IBM Corporation	ATM	NE7
	Intel Corporation	Intel LANDesk	NE10
	Intel Corporation	Adapters	191
892	Octopus Technologies, Inc.	Octopus - NT Backup	NE25
852	Seagate EMS	Seagate Desktop Management Suite	NE29
316	Symantec Winfax Pro	Winfax Pro 7.0	180

MAIL ORDER

336	ARLINGTON COMPUTER PRODUCTS	Mail Order	276
222	Bull Express	PCs, Peripherals	277
	Compag Computer Corporation	Prolinea E	153
387	CompuLink Research	Infinity	251
025	CompUSA Direct	Mail Order	264-265
159	COMPUTER DISCOUNT WAREHOUSE	Reseller	256-257
318	COMPUTER DISCOUNT WAREHOUSE	Reseller	258-259
360	COMPUTER DISCOUNT WAREHOUSE	Reseller	260-261
014	First Source International	Memory, Notebooks, Peripherals	266-267
	Gateway 2000	Notebooks, Desktops, Peripherals, Mail Order	48A-49
391/138	H Co Memory Upgrades	Memory, PCMCIA, Fax/Modem, LAN	250
019	L.A. Trade	Memory	255
165	Magitronic	Notebooks	249
045	Magix	PCs	279
283	MEGAHAUS	Mass Storage	263
119	Micron Electronics	Color Notebooks	24-25
010	Midwest Computer Works	Mail Order	240-241
047	PC Connection	PCs, Peripherals, Software	280
092	PCs Compleat	Notebooks, Peripherals	269
268	PCs Compleat	Notebooks, Peripherals	270-271
051	USA Flex	Notebooks, Desktops, Peripherals	272

MASS STORAGE

283	MEGAHAUS	Mass Storage	263
855	Micro Solutions Computer Products	Tape Backup, CD-ROM, Disk Drive	268
309	S.A.G./Storage Solutions	Pentiums, Servers, Storage Solutions	52-53
378	Seagate Technologies	Tape Drives	206
271	Seagate Technologies	Hard Drives	38

MEMORY

014	First Source International	Memory, Notebooks, Peripherals	266-267
391/138	H Co Memory Upgrades	Memory	250
106	Kingston Technology	Kingston Memory	155
019	L.A. Trade	Memory	255
056	Pro Direct	Mail Order	273
065	VisionTek	Memory Chip Upgrades	227

MISCELLANEOUS

355	Telesys, Inc.	PC Magazine Interactive Phone Card	216
163	Xerox Corporation	Xerox Paper	327

MODEMS

881	Hayes Microcomputer Products	Modems	NE22
327	NECX	Mail Order	243
036	Newcom	Voice Cards	178
056	Pro Direct	Mail Order	273
920	US Robotics, Inc.	Courier I	NE27
211	Xircom	CIMM	23

MULTIMEDIA

059	ATI Technologies	Accelerator Boards	35
025	CompUSA Direct	Mail Order	264-265
096	Creative Labs	Sound Blaster	204
189	Diamond Multimedia Systems	Stealth 3D	323
062	HARTFORD COMPUTER GROUP	Mail Order	247
855	Micro Solutions Computer Products	Tape Backup, CD-ROM, Disk Drive	268
157	NEC Technologies	Monitors	46-47
232	NuReality	3D Sound Enhancement	333
171	Picturetel Corporation	Picturetel PCS	233
196	Plexor	8Plex	28
355	Telesys, Inc.	PC Magazine Interactive Phone Card	216

MULTIMEDIA SOFTWARE

369	Connectix	Ram Doubler	212
314	Corel Corporation	Graphics Pack/Draw & Printhouse	174
037	Corel Corporation	Wordperfect 7.0	26-27
358	Corel Corporation	Corel CAD 3D	321
042	Corel Corporation	Learning Series	324
322	Corel Corporation	Internet Combo	328
011	Corel Corporation	Medical Series	332
041	Corel Corporation	Corel MODE	337
339	Corel Corporation	Office Professional	96

Reader Service

No.	Company	Product	Page
250	Visual Software	Visual Reality 2.0	329

NETWORK INTERFACE CARDS

211	Xircom	CIMM	23
-----	--------	------	----

NETWORKING SOFTWARE

	Intel Corporation	Intel LANDesk	NE10
	Intel Corporation	Networking Products	191
	Oracle Corp.	OLAP	NE5
852	Seagate EMS	Seagate Desktop Management Suite	NE29

ON LINE DATABASE/SERVICES

353	Digital Equipment Corp.	Alta Vista	70-71
	Microsoft	Internet	82-83

OPERATING SYSTEMS

	Microsoft	Internet	82-83
	Novell, Inc.	GroupWise	168-169
	Novell, Inc.	GroupWise	171

OPTICAL PERIPHERALS

334	Kodak Digital Science Solutions	Kodak DC Camera	193
015	Magnavox	LCD Projectors	86

ORGANIZATIONAL SOFTWARE

	Microsoft	Microsoft Office	C2-C4, p1
	Visio	Visio	210-211

ORGANIZATIONS/SERVICES

355	Telesys, Inc.	PC Magazine Interactive Phone Card	216
-----	---------------	------------------------------------	-----

PC ACCESSORIES

232	NuReality	3D Sound Enhancement	333
163	Xerox Corporation	Xerox Paper	327

PC DIRECT

336	ARLINGTON COMPUTER PRODUCTS	Mail Order	276
012	Austin Direct	Austin Direct Desktops & Notebooks	246A-D
222	Bull Express	PCs, Peripherals	277
387	CompuLink Research	Infinity	251
025	CompUSA Direct	Mail Order	264-265
159	COMPUTER DISCOUNT WAREHOUSE	Reseller	256-257
318	COMPUTER DISCOUNT WAREHOUSE	Reseller	258-259
360	COMPUTER DISCOUNT WAREHOUSE	Reseller	260-261
391/138	H Co Memory Upgrades	Memory, PCMCIA, Fax/Modem, LAN	250
062	HARTFORD COMPUTER GROUP	Mail Order	247
219	Insight Direct	Mail Order	274-275
019	L.A. Trade	Memory	255
165	Magitronic	Notebooks	249
045	Magix	PCs	279
386	Maxtor Corporation	Hard Disks	278
283	MEGAHAUS	Mass Storage	263
855	Micro Solutions Computer Products	Tape Backup, CD-ROM, Disk Drive	268
010	Midwest Computer Works	Reseller	240-241
327	NECX	Mail Order	243
047	PC Connection	PCs, Peripherals, Software	280
199	PC Zone	Mail Order	252-253
092	PCs Compleat	Notebooks, Peripherals	269
268	PCs Compleat	Notebooks, Peripherals	270-271
056	Pro Direct	Mail Order	273
043	SPSS, Inc.	Windows & Statistical Software	245
305	Texas Instruments	TI Printers	244
051	USA Flex	Notebooks, Desktops, Peripherals	272

PCMCIA

218	Adaptec	SCSI CD-Recordable	330
391/138	H Co Memory Upgrades	Fax/Modem, Flash, SRAM, Drives	250
920	US Robotics, Inc.	Courier I	NE27
211	Xircom	CIMM	23

PERIPHERAL SHARING DEVICE

881	Hayes Microcomputer Products	Modems	NE22
-----	------------------------------	--------	------

PERIPHERALS

	Canon, U.S.A.	Canon Color Laser Printers	84
095	Creative Labs	Sound Blaster	204
329	CTX International	21" Monitor (PR 900)	74
189	Diamond Multimedia Systems	Stealth 3D	323
	Epson America	Epson Color Ink Jet Printers	10-11
014	First Source International	Memory, Notebooks, Peripherals	266-267
	Gateway 2000	Peripherals	48A-49
881	Hayes Microcomputer Products	Modems	NE22
	Hewlett Packard	JetDirect	177
334	Kodak Digital Science Solutions	Kodak DC Camera	193
015	Magnavox	LCD Projectors	86
232	NuReality	3D Sound Enhancement	333
918	Optical Data Systems	Switches	NE16
047	PC Connection	Peripherals	280
199	PC Zone	Mail Order	252-253
092	PCs Compleat	Peripherals	269
268	PCs Compleat	Peripherals	270-271
884	QMS	1616E	NE30
309	S.A.G./Storage Solutions	Pentiums, Servers, Storage Solutions	52-53
305	Texas Instruments	TI Printers	244

POWER PROTECTION

915	American Power Conversion	Matrix	NE12-NE13
162	American Power Conversion	BackUPS ProPNP	319
080	PC Power & Cooling	Power Protection/Cooling Devices	88

PRINTER ACCESSORIES

	Canon Japan	Canon Printer Cartridges	188
	Hewlett Packard	JetDirect	177

PRINTERS

222	Bull Express	Peripherals	277
	Canon Japan	Canon Printer Cartridges	188
	Canon, U.S.A.	Canon Color Laser Printers	84
	Epson America	Epson Color Ink Jet Printers	10-11

Advertisers' Index PRODUCTS

Reader Service

No.	Company	Product	Page
154	Hewlett Packard	JetDirect	177
884	NEC Technologies	NEC printers	30
305	QMS	1616E	NE30
051	Texas Instruments	TI Printers	244
051	USA Flex	Printers	272
PROGRAMMERS TOOLS UTILITIES			
038	Powersoft	Powerbuilder	2-3
PROJECT MANAGEMENT SOFTWARE			
148	Microsoft	Microsoft Office	C2-C4, p1
148	Primavera Systems	Suretrak 1.5 and P3	61
REMOTE COMPUTING			
911	Gandalf Technologies Inc.	XPressConnect LANline 52421	NE15
299	Hewlett Packard	HP OmniBook 5000	81
186	McAfee Associates, Inc.	WebScan	62
308	Symantec Corporation	Peter Norton Group PCAnywhere	157
920	Symantec Corporation	Win 95 - Navigator	18
920	US Robotics, Inc.	Courier I	NE27
SERVERS			
012	Austin Direct	Austin Direct Desktops & Notebooks	248A-D
934	Axis Communications, Inc.	Axis CD-Server	NE9
924	Hewlett Packard	Netservers	57
309	Micron Electronics	Micron Servers	NE2-NE3
335	S.A.G./Storage Solutions	Pentiums, Servers, Storage Solutions	52-53
023	Sun Microsystems	Solaris	222-223
023	Sun Microsystems	Natra Server	5
023	Unisys Corporation	Unisys PCs and Servers	64-65
SOFTWARE			
314	Corel Corporation	Graphics Pack/Draw 6/PrintHouse	174
037	Corel Corporation	Wordperfect 7.0	26-27
339	Corel Corporation	Office Professional	96
219	Insight Direct	Mail Order	274-275
040	Intel Corporation	Intel LANdesk	NE10
040	Intel Corporation	Adapters	191
040	Intergraph Corporation	Imagineer	50
006	Lotus Development Corporation	SmartSuite	20-21
006	Luckman Interactive	Web Commander	220
299	McAfee Associates, Inc.	WebScan	62
214	Micrografix	ABC Graphics Suite	67
214	MicroHelp Inc.	Uninstaller	183
214	Microsoft	Microsoft Office	C2-C4, p1
148	Oracle Corp	OLAP	NE5
043	Primavera Systems	Suretrak 1.5 and P3	61
043	SPSS, Inc.	Windows & Statistical Software	245
186	Symantec Corporation	Peter Norton Group PCAnywhere	157
308	Symantec Corporation	Win 95 - Navigator	18
250	Visio	Visio	210-211
250	Visual Software	Visual Reality 2.0	329
STATISTICAL SOFTWARE			
043	SPSS, Inc.	Statistical Software	245
057	Statsoft	Statistical Software	45
TELECOMMUNICATIONS			
355	Telesys, Inc.	PC Magazine Interactive Phone Card	218
UTILITIES			
006	Luckman Interactive	Web Commander	220
299	McAfee Associates, Inc.	WebScan	62
214	MicroHelp Inc.	Uninstaller	183
VIDEO GRAPHICS/BOARDS			
189	Diamond Multimedia Systems	Stealth 3D	323
WINDOWS SOFTWARE			
299	McAfee Associates, Inc.	WebScan	62
214	Micrografix	ABC Graphics Suite	67
214	MicroHelp Inc.	Uninstaller	183
214	Microsoft	Microsoft Office	C2-C4, p1
148	Primavera Systems	Suretrak 1.5 and P3	61
043	SPSS, Inc.	Windows Software	245
057	Statsoft	Statistical Software	45
250	Visio	Visio	210-211
250	Visual Software	Visual Reality 2.0	329
WORD PROCESSING SOFTWARE			
214	Lotus Development Corporation	SmartSuite	20-21
WORK GROUP SOFTWARE			
171	Lotus Development Corporation	SmartSuite	20-21
171	Picturetel Corporation	Picturetel PCS	233
WORKSTATIONS			
171	Hewlett Packard	HP Vectra PCs	78-79
171	Picturetel Corporation	Picturetel PCS	233

For Additional Categories see MARKETPLACE PRODUCT INDEX 281.



Coming Up

THE PERFECT PC

The Perfect System Looking for the perfect system? We've put together a list of features and peripherals that help you get the most from your machine. We also examine the components and configurations that make up the best application or file server you can buy today.

The Perfect Components Most of you have probably sprung for the Pentium and jumped on the Internet—and are surfing to your heart's content. But is something still missing? We present our version of the perfect PC. Find out what constitutes the perfect peripheral bus, graphics adapter, monitor, hard disk, CD-ROM drive, removable media, and sound system.

The Perfect Connections Building and managing a network has never been easy, and now it's becoming even more complex. More network users are asking for Internet access, new intranet tools are providing more choices for sharing information, and at the same time, network managers must confront fundamental networking needs such as management and backup. We examine what's important for networks of all sizes—from small-office connections to WAN links and the perfect Internet connection.

PC Service & Reliability, Software Support & Satisfaction Ever wonder how other users feel about using the same PC and software you use? In our annual Service & Reliability and Support & Satisfaction surveys, our subscribers rate how much they like their PCs (desktop or notebook) and their software packages, respectively; they also tell how they feel about the technical support they've received. In addition, we interview a few readers about some of the trends we've been seeing in software usage during the past year and then examine these trends in greater depth in analyses of each of the six software categories.

The PC Magazine 150 Find out what you need to know about the companies that manufacture your products. We give you the latest financial profiles for 150 of the largest PC, server, peripheral, networking, and software vendors.

ALSO IN THE ISSUE

Summer Games No, we don't mean the Olympics! This is our summertime roundup of new and exciting PC games. We review 25 of the latest and tell you which are gold-medal winners and which should be disqualified. You'll also find tips on hot games to look for in the coming months.

Editorial Product Index

Reader Service No.	Product	Company	Page
513	AccelGraphics AccelR8	AccelGraphics Inc.	192
441	ACMA sPower 133	ACMA Computers Inc.	108
441	ACMA zPower133 and zPower166	ACMA Computers Inc.	108
442	ACW P5-166BP	All Computer Warehouse	126
443	AMAX Powerstation 133Fand 166F	AMAX Engineering Corp.	126
427	Amortizer96	Outlook Software Corp.	60
444	AST Bravo MS 5166	AST Computer	135
506	ATI Graphics Pro Turbo	ATI Technologies Inc.	182
445	Austin PowerPlus 133 and 166	Austin Direct	135
496	Automap Road Atlas 4.0	Microsoft Corp.	335
417	Axum 4.1	MathSoft Inc.	76
422	Back-UPS Office	American Power Conversion	80
446	Blue Star Eclipse E-133 and P-166	Blue Star Marketing Inc.	136
447	CompuTrend Premio Triton P133 and P166	CompuTrend Systems Inc.	136
448	Comtrade Hyperspeed Multimedia	Comtrade	137
448	Comtrade Wide SCSI Powerstation	Comtrade	137
431	Corel Web.Data 1.0	Corel Corp.	44
449	CSS Preferred MT 5/133 and MT 5/166	CSS Laboratories Inc.	138
428	DacEasy Accounting & Payroll for Windows 95	DacEasy Software	60
452	Daimond Office Mate 133 and Office Intelligent 166	Diamond Technologies Inc.	140
450	Data Storage DataStor P5-133 and P5-166	Data Storage Marketing Inc.	138
451	Dell Dimension XPS P133c and XPS P166s	Dell Computer Corp.	139
451	Dell OptiPlex GXMT 5133 and 5166	Dell Computer Corp.	139
514	Diamond FireGL	Diamond Multimedia Systems Inc.	194
507	Diamond Stealth64 Video 3400XL	Diamond Multimedia Systems Inc.	182
453	Digital Celebris GL 5166ST	Digital Equipment Corp.	140
951	DiracPC Access Kit, Model 40	Hughes Network Systems	NE23
429	Director 5 for Windows	Macromedia Inc.	39
454	DirectWave Blue Thunder PHX133 and PH166	DirectWave Inc.	141
491	Doc-To-Help 2.0	WexTech Systems Inc.	208
455	DTK QUIN-55M/P166	DTK Computer Inc.	144
515	Dynamic Pictures V192 Graphics Accelerator Module	Dynamic Pictures Inc.	194
516	ELSA GLoria 8	ELSA Inc.	199
508	ELSA Winner2000 Pro/X4	ELSA Inc.	184
456	EPS Evolution LP-133 and XLP-166	EPS Technologies Inc.	144
457	Everex Step Premier 133 and 166	Everex Systems Inc.	145
457	Everex Tempo Select 133 and 166	Everex Systems Inc.	145
501	FloorPlan PLUS 3D	IMSI	322
492	ForeHelp 2.95	ForeFront Inc.	209
424	4th Dimension, Version 4.0	Thinking Man Software	56
426	Fractal Poser	Fractal Design Corp.	54
517	Fujitsu Sapphire 2SX and 3D Designer	Fujitsu Microelectronics Inc.	200
458	Gateway P5-133 and P5-166	Gateway 2000 Inc.	146
459	GST/Micro City Aapogee P133 and P166	GST/Micro City Inc.	147
460	HD Victoria P-120 and P-166	HD Computer	147
494	HelpBreeze 2.0	Solutionsoft	215
493	Help Magician Pro 95	Software Interphase Inc.	213
509	Hercules Terminator Professional	Hercules Inc.	189
461	Hertz Z-Pent P133e and P166e	Hertz Computer Corp.	148
405	Hewlett-Packard DesignJet 755CM	Hewlett-Packard Co.	51
463	HiQuality HiQ P133 Mars Station and P166	HiQuality Computer Systems	149
500	Home Design 3D	Expert Software Inc.	320
462	HP 500 Model 515MCx 5/166	Hewlett-Packard Co.	148
462	HP Vectra XM Series 4 5/120, 4 5/133, and 4 5/166	Hewlett-Packard Co.	148
464	IBM PC 350 P133 and P166	IBM Personal Computer Co.	150
423	IBM ThinkPad 560	IBM PC Co.	75
416	Interactive Manager	Harvard Business School Publishing New Media Group	76
952	InterNotes Web Publisher 4.0	Lotus Development Corp.	NE24
411	JASCapture	JASC Software Inc.	75
406	Magic Artist Stretch Canvas	Rexam Graphics	48
510	Matrox Millennium	Matrox Graphics Inc.	190
465	Maximus Magna P/133, Graphics P/166, and SCSI P/166	Maximus Computers Inc.	150
466	Mega Impact 5133PCI16D and 5166	Mega Computer Systems	150
467	Memorex Telex Celerria Mini Tower	Memorex Telex Corp.	152
468	Micro Express MicroFlex-686/P166+	Micro Express	152
469	Micron Millennia 133, 166, and Millennia Plus	Micron Electronics Inc.	152
413	Microsoft Bookshelf 1996-97 Edition	Microsoft Corp.	76
470	MidWest Micro P5-133 Office PC and P5-166	MidWest Micro	154
414	MultiPass C2500	Canon Computer Systems Inc.	76
499	The Muppet CD-ROM: Muppets Inside	Starwave Corp.	336
502	myHouse for Windows 2.0	DesignWare Inc.	325
472	NEC PowerMate V133 and P166	NEC Technologies	156
473	NETis N5166-ED PowerStation	NETis Technologies Inc.	156
953	NetWare 4.1 SMP	Novell Inc.	NE26
471	NMC Expert Plus 133 and 166	National Microcomputers Inc.	154
425	Nokia Multigraph 447Xav	Nokia Display Products Inc.	56
511	Number Nine Imagine 128 and Imagine 128 Series 2	Number Nine Visual Technology	192
519	Oki TrianGL 16P and 24P	Oki America Inc.	202
521	Omicomp 3Demon SX88	Omicomp Inc.	203
409	OmniPage Pro for Windows 95 Version 7.0	Caere Corp.	75
403	OmniPost Analyzer	Omni Diagnostics Inc.	66
411	Paint Shop Pro Power Pack	JASC Software Inc.	75
404	PaperMaster 2.0	DocuMagix Inc.	66
503	Planix Home Designer 3D 2.0	Softdesk Retail Products	326
474	Polywell PolyStation 133P and 166P	Polywell Computers Inc.	156
407	PosterWorks 4.0 for Windows	S. H. Pierce & Co.	51
410	Power Storage Hard Drive Kit	Adaptec Inc.	75
420	PowerSearch	CommTech Software	80
419	Procomm Plus	Datastorm	80
475	Quantex QP5/133 SM-2 and QP5/166	Quantex Microsystems Inc.	158
498	Rand McNally TripMaker 1996 Edition	Rand McNally New Media	336
476	Reason Savvy TR/Model 1 and 2	Reason Technology Inc.	158
476	Reason Square 5 DP-TR2/HX and TR/ITX	Reason Technology Inc.	158
497	Road Trips	TravRoute Software	335
495	RoboHelp 95, Revision A	Blue Sky Software Corp.	214
477	Robotech Cobra XLT/2 P133 and P166	Robotech Inc.	158
478	Royal Ultra Media Pro and Media 96 Pro	Royal Computer Inc.	163
479	S.A.G. STA Dual 166 Ultra	S.A.G. Electronics	163
402	SmartBoard, Version 1.0	Insight Software Solutions Inc.	63
480	Summit Mount Olympus and Mount Shasta	Summit Micro Design	163
418	SuperScript 860	NEC Technologies Inc.	80
481	Swan PowerHouse Deluxe 133 and 166	Swan Technologies Corp.	164
522	Symmetric Glyder 16	Symmetric	203
482	Sys Performance P133T2A and C166T2A+	Sys Technology Inc.	164
483	Tagram Thunderbolt Office Station P-133	Tagram System Corp.	164
483	Tagram Thunderbolt Virtual Studio P-166	Tagram System Corp.	164
484	Tangent MediaStar 5133 and 5166	Tangent Computer Inc.	166
485	Tatung TCS-5100 and TCS-5900	Tatung Co. of America	166
408	TextBridge Pro 96 for Windows 95	Xerox Document Systems	75
504	3D Home Architect	Broderbund Software Inc.	331
505	3D Kitchen and 3D Landscape	Books That Work	326
401	Tim Berry's Business Plan Pro	Palo Alto Software Inc.	63
432	Toshiba Tecra 720CDT	Toshiba America Information Systems	39
415	Tsunami MT 5.0	NeocorTechnologies	76
412	28.8 Communicator	Simple Technology Inc.	75
415	Typhoon MT 5.0	NeocorTechnologies	76
486	Unisys CWP-51333 and CMT-51667	Unisys Corp.	166
487	Unitek Skyraider	Unitek Technology Inc.	170
421	UPStart Uninterruptible Power Center	SL Waber	80
488	USA Flex PT133 Multimedia Special	USA Flex	170
489	US Computer Freedom LX+ and Patriot LX+	US Computer Direct	170
490	Vektron Optima Station P133 and Power Pro P166	Vektron	171
430	WebAnalyzer	InContext Systems	44

NE—Network Edition.

For information about the Network Edition of *PC Magazine*, call Circulation at 800-289-0429.

Abort, Retry, Fail?

THE LIGHTER SIDE OF PERSONAL COMPUTING

By Don Willmott

Beeper Bleeper

Contributing editor Bruce Brown finds that his pager gets confused by interference at PC Labs. The day after the New Hampshire primary, this garbled news report was displayed on his pager's LCD screen: "Primary victor Pat Buchanan and losers Bob Dole and Lamar Alexander are vowing a bloody fight. . . . Dole and Alexander are each calling the other people and spilling sulphuric acid. Hazardous materials crews are on the scene."



Multimedia That We Definitely Didn't Ask For

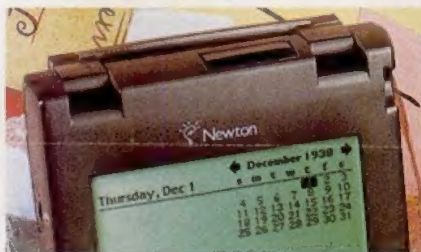
"What we are creating is a unique new form of content assets," says Simon Langdon, director of business operations for Dow Jones' multimedia division. "We now have over two years' worth of video encounters, with the Who's Who of business sitting in the can." —INTER@CTIVE WEEK



Here at ARF, low standards are the name of the game! (DTP direct catalog.)

Classified Intelligence

"Programmer Analyst: The successful applicant will have a computer science degree with 3-5 years experience. Proficiency with C, Unix is required. A pilot's license is also desirable." —PEAK COMPUTING CLASSIFIEDS



1:00 P.M. lunch with Roosevelt. 7:00 P.M. dinner with Clark Gable. (Newton World.)

Bill Gates for President!

And why not? As a very unofficial Web site (<http://www.gates96.org>) suggests, Bill could use his \$15 billion fortune to buy 96 million votes at a cost of \$156.25 per vote. Per capita, Steve Forbes paid much more.



RICHARD TENNANT

If your entry is used, we'll send you \$50 and a *PC Magazine* T-shirt. Send your entries to Abort, Retry, Fail?, *PC Magazine*, One Park Ave., New York, NY 10016-5802 or via e-mail (text items only) to don_willmott@zd.com. Winners this issue: Jerry Bidmead, Bruce Brown, Jerry Custis, Will Daniel, John Stelling, and Tom Tharp.

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Dell's featured computer artist is Diane Fenster of Pacifica, CA.

It's the memory of the future: Synchronous Dynamic RAM (SDRAM to you). And this new Dell Dimension XPS has it. Finally, your PCs won't be held back by the limitations of asynchronous EDO memory. Finally, with everything tied to the same clock, you can get smooth, predictable performance at astonishing speeds. Finally, you can have a hedge against obsolescence. And, the technology once reserved for high-end workstations can be on your desktop. So check out the specs, limber up your dialing finger and give us a call. Come to think of it, maybe you should tie a string around that finger first.

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